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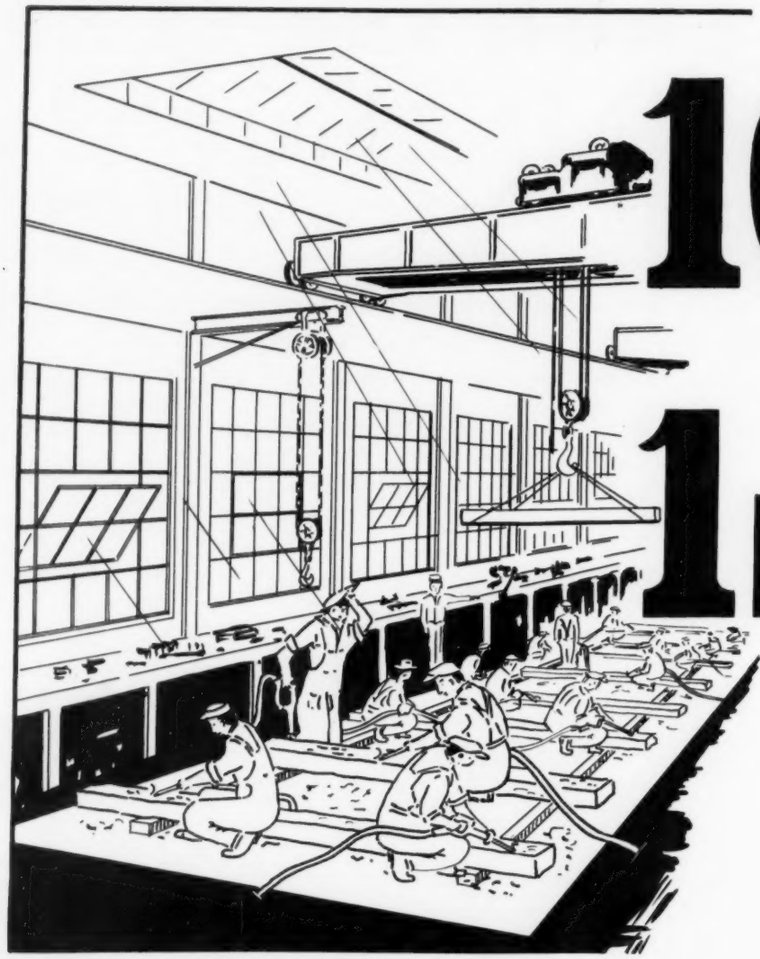
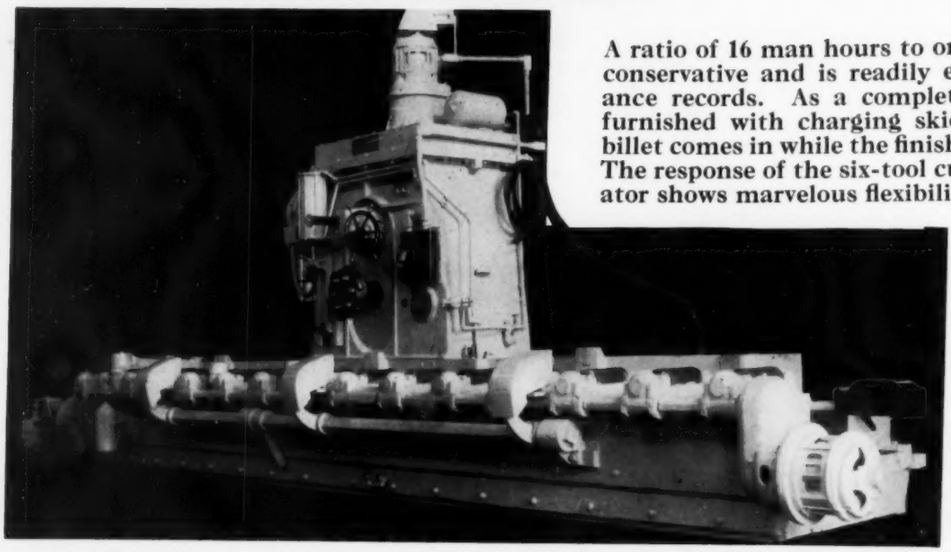


16 MEN or 1 BILLETEER?

HAND CHIPPING VS MACHINE

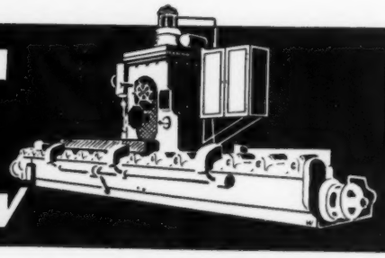


A ratio of 16 man hours to one machine hour is very conservative and is readily established by performance records. As a complete unit the Billeteer is furnished with charging skids and kick-off—a new billet comes in while the finished billet is discharging. The response of the six-tool cutting head to the operator shows marvelous flexibility. All controls for the complete unit are within convenient reach of the operator. Responding instantaneously to these controls, it is the most rapid and economical method of billet cleaning. Repeated orders prove its merits. Are you paying for one without having it? Let's talk it over.

CANTON OHIO

BONNOT

STEEL EQUIPMENT DIVISION



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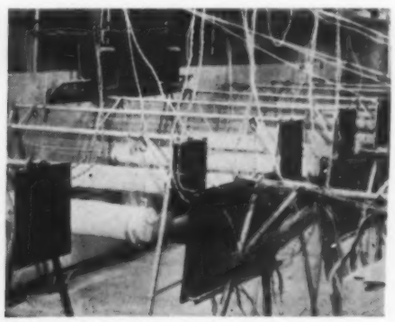
HOW RESEARCH HELPS CUT YOUR FUEL BILL

1 Less than thirty years ago, there was no satisfactory insulating material for high-temperature industrial equipment. No known substance combined low conductivity and the necessary heat resistance. But in 1912, when Sil-O-Cel Brick and other diatomaceous silica insulations appeared, heat waste ceased to be a necessary evil. Later developments of the J-M Insulation Research Laboratory, notably Superex Blocks, made it possible for steel mills and metal-working plants to bring heat even more completely under control. Today, there is a Johns-Manville Insulation for every type of heated or refrigerated industrial equipment.

2 3200° F. is the temperature of this Ajax Northrup electric furnace, used to test high-temperature insulations in the J-M Laboratories. Such temperatures, far above the ordinary range of industrial processes, make it possible to check in advance the exact behavior of J-M insulations under severe conditions.

3 Electrical current, accurately measured, is the source of heat for all thermal-conductivity tests in the J-M Laboratory. Power input to any heater in the laboratory may be measured at this switchboard to within ½ of 1%.

4 Measuring the efficiency of high-temperature insulating materials is difficult, for ordinary testing equipment breaks down under high heat. But this J-M testing unit gives accurate conductivity data up to 2600° F.



5 Pipe Insulation is tested for thermal conductivity on these electrically heated pipe sections. The room is kept at constant temperature under thermostatic control. Accuracy is safeguarded at every point.

6 "Jack" Switchboard to which is connected the thermocouples used in the various testing units. Here, with the aid of a single precision potentiometer, temperatures are measured to within ⅓ of 1° F. Temperatures may be measured at approximately 800 different points.

SINCE its beginning over 80 years ago, Johns-Manville has pioneered in the development of materials and methods to help industry control heat, and use it with maximum efficiency and economy.

Today, it is conservatively estimated that J-M Insulating Materials are saving American Industry over $250,000,000 annually in fuel alone . . . bringing substantial benefits, too, through improved temperature control and better working conditions. In large measure, this achievement can be credited to the J-M Insulation Research Laboratory at Manville, N. J., scenes from which are shown here.

The story of this laboratory and of what it is doing to solve tomorrow's insulation problems is told in the handbook, "Heat." This interesting book also gives useful information on the full line of J-M Insulations for all industrial purposes. If heat conservation is one of your problems, you'll find this book most helpful. For your copy, write Johns-Manville, 22 East 40th Street, New York, N. Y.

Johns-Manville

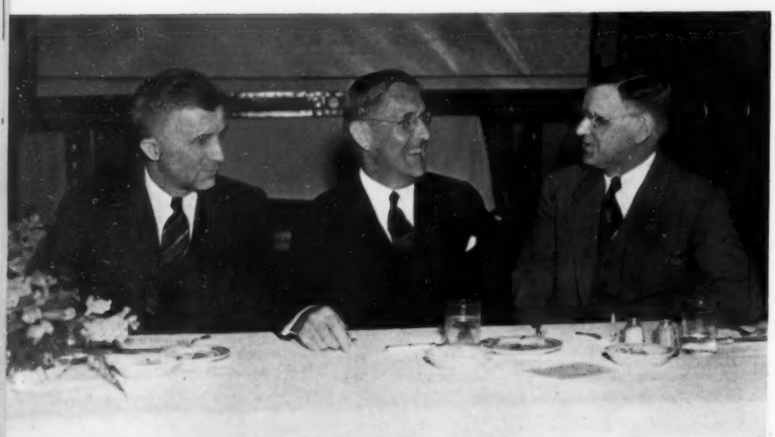
INSULATIONS FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE CONDITION

Officially opening the conference with an informal dinner, the above view is that of the speaker's and guests' table. From left to right are shown: W. H. Burr, H. F. French, James Farrington, F. E. Rickets, P. F. Dolan, W. G. Ewald, F. O. Schnure, S. J. Cort, L. F. Coffin, Adam Hazlett, G. R. Carroll, F. A. Allner, G. O. Van Artsdalen, and F. E. Flynn.

REVIEW of ANNUAL SPRING CONFERENCE

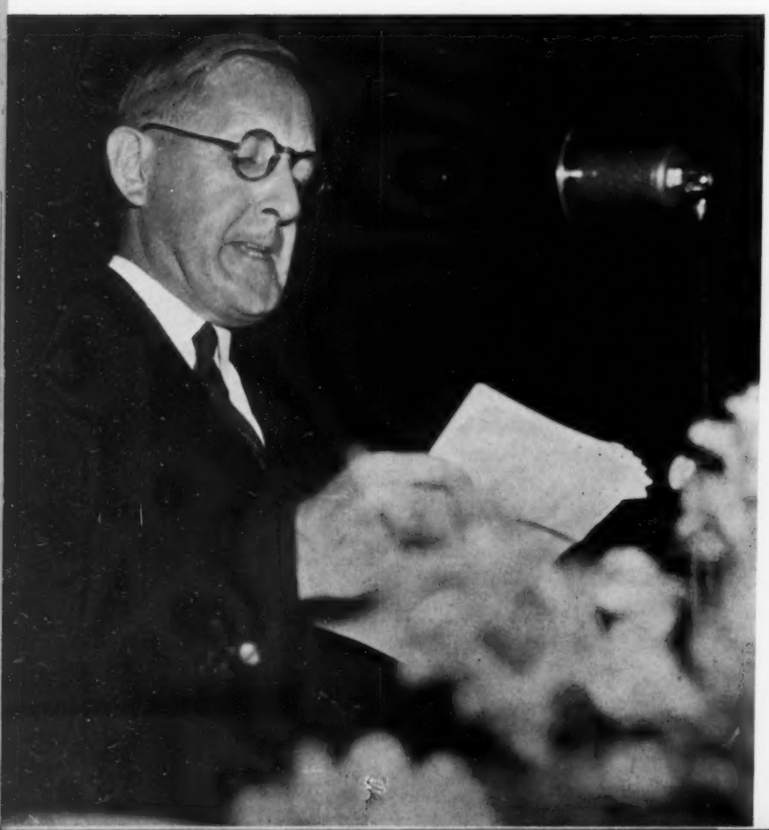
THE annual spring engineering conference of the Association, held in Baltimore, Maryland, April 28 and 29, was considered by many to have been one of the most successful mid-year meetings ever sponsored by the Association. A large portion of the credit for the success of this meeting must be extended to the personnel of the Bethlehem Steel Company's Maryland Plant. Together with Stewart J. Cort, general manager of the Maryland Plant, L. F. Coffin, president of the Society, and F. O. Schnure, general chairman of the arrangements committee, they left nothing undone in arranging every detail of the conference to function perfectly.

The meeting opened on the evening of April 28 with an informal dinner, at which Mr. Cort, general manager of the Maryland Plant, was very lavish in his praise for the splendid work being carried on by the Association. Mr. Cort also outlined the marvelous growth the Maryland Plant has experienced in the last twenty years, with special emphasis on the recently completed modernization program which included a new 56″ continuous hot strip mill, and a high speed bar and rod mill. Before Mr. Cort delivered his remarks the members had the privilege of listening to a fifteen minute radio broadcast, in which W. G. Ewald, secretary of the Baltimore Association of Commerce, outlined the reasons for this meeting being held in Baltimore, as well as to explain the work being carried on by the Association of Iron and Steel Engineers.

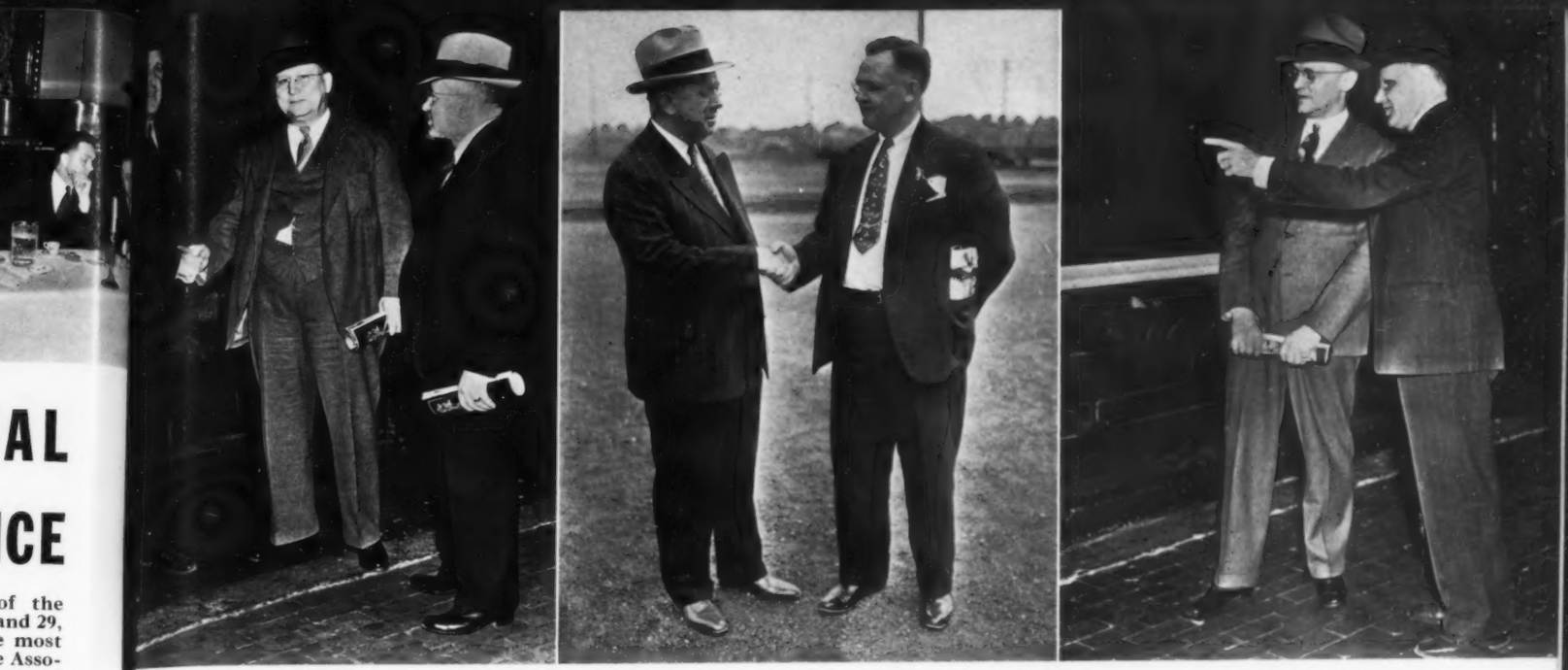


In the above picture the three men most responsible for the success of the conference are illustrated. F. O. Schnure, general chairman of the arrangements committee, at the left, S. J. Cort, general manager of the Maryland Plant, center, and L. F. Coffin, president of the Association, on the right.

Below is shown S. J. Cort officially welcoming the Association to Baltimore. Mr. Cort spoke highly of the Association's activity in furthering the advancement of engineering in the steel industry.



L. F. Coffin, president of the Association, officially acknowledged Mr. Cort's welcome to Baltimore. He also spoke of the necessity for the Association to continue its expansion of worthwhile projects for the steel industry.



S. J. Cort acted the part of a genial host at all times, and in the upper left view is seen welcoming J. S. Pastorius, (center) general superintendent of the Great Lakes Steel Corporation, and J. A. Clauss, chief engineer of the same plant, to the Maryland Plant. The center illustration is that of Frank E. Flynn, general manager of the Warren district, Republic Steel Corporation, greeting J. S. Murray, chief electrical engineer of the Follansbee Brothers Company. In the upper right view, L. F. Coffin is pointing out to C. L. McGranahan, assistant general superintendent of Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania, some of the features of the 56" hot strip mill.

Following the dinner the technical session was formally opened with C. J. Duby, chief engineer, Warren-Youngstown district, Republic Steel Corporation, and A. S. Glossbrenner, superintendent of the hot strip mill, Youngstown Sheet and Tube Company, Youngstown, Ohio, presiding. The first paper was entitled: "Instrumentation of a Modern Hot and Cold Strip Mill", presented jointly by J. L. Whitten, Brown Instrument Company, Pittsburgh, Pennsylvania, and by R. H. Ellis, United Engineering and Foundry Company, Pittsburgh, Pennsylvania. The second paper was on the subject of "Forged Rolls", delivered by J. R. Adams, superintendent, special products, Midvale Steel Company, Philadelphia, Pennsylvania. The concluding paper of the evening was presented by George F. Bowers, Standard Oil Company of Indiana, Chicago, Illinois, in which he reviewed the subject of: "The Chemistry of Lubrication".

The Friday morning program was opened with a "Get-together" Breakfast following which a paper entitled "A Study of the Power Requirements of a 56" Hot Strip Mill" was presented jointly by F. O. Schnure, electrical superintendent, Bethlehem Steel Company, Sparrows Point, Maryland, and by R. H. Wright, engineering department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania. This very comprehensive paper is appearing in the current issue of the IRON AND STEEL ENGINEER. L. A. Umansky, General Electric Company, Schenectady, New York, brought the technical program of the conference to a fitting close with the presentation of a paper on the subject of: "Special Problems of Steel Mill Electrification". George O. Van Artsdalen, superintendent, maintenance department, Henry Disston & Sons, Inc., Philadelphia, Pennsylvania and F. O. Schnure presided at this morning session.

Promptly at twelve-thirty P. M., the first of a calvacade of busses left the Lord Baltimore Hotel carrying the first group of five hundred members and guests who spent the afternoon inspecting the Maryland Plant of the Bethlehem Steel Company. The Maryland Plant personnel is certainly to be congratulated for their marvelous work in arranging for such an interesting and enjoyable trip. Every courtesy was extended to the members of the Association which hospitality was deeply appreciated.

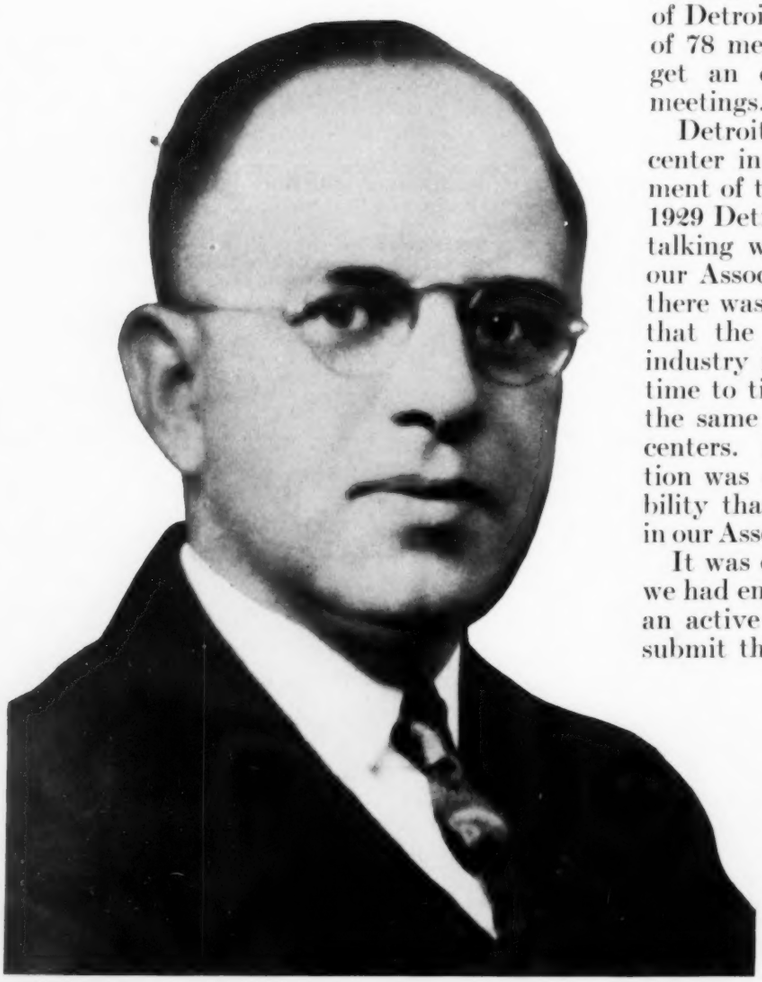
Below is shown a general view of the group on the Inspection Trip. In the foreground may be seen, L. V. Black, assistant electrical superintendent, Bethlehem Steel Company, Bethlehem, Pennsylvania; George Pfeffer, electrical superintendent, Florence Pipe Foundry and Machine Company, Florence, New Jersey, and E. E. Helm, district engineer, Reliance Electric and Engineering Company, Philadelphia, Pennsylvania.

The Inspection Trip attracted many personalities from the strip mill industry, the lower illustration showing Harry Stevens, chief engineer, Bethlehem Steel Company, Maryland Plant, (right) conducting J. H. Vohr, general superintendent, Granite City Steel Company, Granite City, Illinois, and A. S. Glossbrenner, superintendent of hot strip mill, Youngstown Sheet and Tube Company, Youngstown, Ohio, through the plant.

A. I. & S. E. ANNOUNCES *Detroit Section*

FORMAL OPENING OF SIXTH DISTRICT SECTION SET FOR WEDNESDAY, JUNE 1, 1938

PRESIDENT L. F. COFFIN WILL PARTICIPATE IN CEREMONY



By their decision to establish a Detroit section of the Association of Iron and Steel Engineers, the national officers and directors of the Association have again given evidence of their progressive attitude in fostering ideas for the benefit of the membership and the advancement of the Steel Industry.

As a member who has been honored by elective office and membership on the board of directors for many years, I know from personal experience that the men who have been elected to guide the destiny and manage the affairs of this Association have been able and conscientious in the discharge of their duties. The flourishing condition of our Association shows the wisdom of the course followed.

At our annual spring conference in Baltimore on April 28th, it was my privilege to submit to the board of directors a request that the Association establish a Detroit section.

There are in Detroit 58 active and 14 associate members, with 6 members living outside of Detroit, but within the Detroit area a total of 78 members. Very few of these members get an opportunity to attend our annual meetings.

Detroit is the largest single steel-consuming center in the world, and with the establishment of the Great Lakes Steel Corporation in 1929 Detroit became very steel conscious. In talking with men eligible for membership in our Association, I was repeatedly asked why there was not a Detroit section established so that the many men interested in the steel industry in this area could get together from time to time and discuss their local problems the same as is being done in five other steel centers. I was assured that, if a Detroit section was established, there was a good possibility that many men eligible for membership in our Association would apply for membership.

It was only after I had assured myself that we had enough local members who would take an active part in a section's activities did I submit the request to the board of directors.

JULIUS A. CLAUSS

Chief Engineer, Great Lakes Steel Corporation and founder of Detroit Section.

I had previously talked to a large number of our members from all of the other sections regarding a Detroit section and was given much kindly advice and encouragement.

It is a matter of personal gratification that the suggestion that a Detroit section be established was received with enthusiasm by the national officers and directors. Upon my return from Baltimore I passed the word around that a Detroit section was to be established and many were the pledges of support that I received. I believe a good start is half the battle, and I am hoping that we can get this section organized so that we will be all ready to function when the fall programs are started.

Detroit is somewhat different than other steel centers in that outside of the men directly engaged in the Steel Industry very little is known of steel mill practice by men who contact the Industry and would be eligible for associate membership. This is true also of many men connected with the local industries. All of these people are extremely anxious to familiarize themselves with steel mill practice, because it would be of great assistance to them in their work and the contacts which they would form by association with steel mill men would naturally result in direct benefit to their respective companies.

I have talked to some of the men in the local power company and feel that we can expect a number of members from this company, and I have already been assured of their cooperation in conducting our meetings; in fact, I have been invited to hold the opening meeting in the new auditorium of this local power company.

I feel confident that the same generous cooperation will be had from other local companies, because the engineers of the automotive industries are a very progressive group of men and leave no opportunity go by which will broaden their field of knowledge.

There are also several small steel rolling mills in this area which we have yet to contact. We expect no trouble in including the men eligible in these companies to become active members.

Our problem now is to select the proper type of men to head this Detroit section. We are holding some informal meetings for the purpose of discussing this matter and hope to be able to submit our recommendations to the national officers within the next few days. With their approval we are looking forward to a visit from our national officers to inaugurate and establish the Detroit section, which, if it lives up to Detroit's tradition, will be a vigorous and active addition to our Association's activities.

The formal opening of this new Detroit section will take place Wednesday, June 1, at 8:00 P.M., in the new auditorium of the Detroit Edison Company, Glass Building, 2000 Third Avenue, Detroit, Michigan. Mr. L. F. Coffin, president of the Association will make the formal announcement of the officers and committee members of the new section. Another feature of the meeting will be the showing of sound motion pictures of the operation of the 96″ strip mill at the Great Lakes Steel Corp.

View of Detroit showing skyline from the Detroit River

G. R. CARROLL

Chairman Membership Committee

George R. Carroll, Chairman of the Membership Committee, is to be congratulated on the splendid work being done by that committee. On this and the following three pages is shown a portion of the many new members of the Association. To date, since the beginning of this year, over 250 applicants for membership have been received. The outstanding work being done by Mr. Carroll and his committee could be considered a reflection of the progressive strides made by the Association.

NEW *Active* MEMBERS

L. B. ROBERTSON,
General Superintendent,
Wisconsin Steel Works,
International Harvester Company,
South Chicago, Illinois.

W. I. McINERNEY,
Superintendent,
Heat Treating and Cold Drawing Dept.,
Pittsburgh Crucible Steel Company,
Midland, Pennsylvania.

LOUIS F. ZANINI,
Blast Furnace Superintendent,
Great Lakes Steel Corporation,
Hanna Furnace Division,
Detroit, Michigan.

THOMAS H. BOYD,
Assistant Blast Furnace Superintendent,
Great Lakes Steel Corporation,
Hanna Furnace Division,
Detroit, Michigan.

GEORGE W. CUBBAGE,
Master Mechanic,
Great Lakes Steel Corporation,
Hanna Furnace Division,
Detroit, Michigan.

H. L. COE,
Assistant Electrical Superintendent,
Carnegie-Illinois Steel Corporation,
Mingo Junction, Ohio.

C. C. ESCH,
Assistant Superintendent,
56" Hot Strip Mill,
Bethlehem Steel Company,
Sparrows Point, Maryland.

R. C. SCHAEFER,
Assistant Superintendent,
Hot Strip Mill,
Wheeling Steel Corporation,
Steubenville, Ohio.

C. S. McKINNEY,
General Master Mechanic,
Republic Steel Corporation,
Warren, Ohio.

MARTIN A. HOTHAM,
Open Hearth Superintendent,
Stanley Works,
Bridgeport, Connecticut.

L. F. REED,
Assistant Superintendent,
Tin Plate Department,
Jones & Laughlin Steel Corporation,
Aliquippa, Pennsylvania.

E. EARL MOORE,
General Superintendent,
Carnegie-Illinois Steel Corporation,
Gary Works, Gary, Indiana.

HENRY P. KEISER,
Chief Electrician,
Blast Furnace,
Great Lakes Steel Corporation,
Hanna Furnace Division,
Detroit, Michigan.

GEORGE KIAH,
Assistant Master Mechanic,
Blast Furnace,
Great Lakes Steel Corporation,
Hanna Furnace Division,
Detroit, Michigan.

LOUIS MOSES,
Superintendent,
Rail Mill and Roll Department,
Bethlehem Steel Company,
Sparrows Point, Maryland.

CLARENCE W. ANDREWS,
Superintendent,
Annealing Department,
Carnegie-Illinois Steel Corporation,
Vandergrift, Pennsylvania.

G. H. DeGARMO,
Assistant Superintendent,
Republic Steel Corporation,
Niles, Ohio.

R. M. LANG,
Superintendent,
Rod and Bar Mills,
Atlantic Steel Company,
Atlanta, Ga.

FRED S. HIGH,
Superintendent,
Finishing Mills and Roll Shop,
Pittsburgh Crucible Steel Company,
Midland, Pennsylvania.

ROBERT E. O'BRIEN,
Galvanizing Superintendent,
Jones and Laughlin Steel Corporation,
Pittsburgh, Pennsylvania.

D. A. HUMPHREY,
Electrical Superintendent,
Wheeling Steel Corporation,
Yorkville, Ohio.

WILLIAM I. MANLEY,
Superintendent,
Mechanical Department,
Republic Steel Corporation,
Youngstown, Ohio.

HAROLD C. COX,
Assistant Superintendent,
Steam and Combustion Department,
Bethlehem Steel Company,
Cambria Plant, Johnstown, Pennsylvania.

F. R. BURNETTE,
Assistant Chief Engineer,
American Steel and Wire Company,
Cleveland, Ohio.

JOSEPH H. DILLON,
Chief Engineer,
Wisconsin Steel Works,
International Harvester Company,
Chicago, Illinois.

WM. F. BARTHOLOMEW,
Assistant Chief Engineer,
Republic Steel Corporation,
Warren, Ohio.

WARREN W. SCHERER,
Assistant Superintendent of Construction,
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Irvin Works,
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W. H. COLLISON,
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By-Product Coke Plant,
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JOHN C. ROYSTON,
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Bethlehem Steel Company,
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CHARLES P. BETZ,
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H. V. LAUER,
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Coke Plant—Gary Works,
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Gary, Indiana.

BRYANT BANNISTER,
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National Tube Company,
Pittsburgh, Pennsylvania.

WALDO C. SMYTH,
General Electrical Foreman,
Plant No. 1
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East Chicago, Indiana.

D. C. MILLS,
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Bethlehem Steel Company,
Sparrows Point, Maryland.

W. C. QUEER,
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Machine Shops,
Inland Steel Company,
East Chicago, Indiana.

P. C. VETTER,
Draftsman—Squad Foreman,
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NICK TRBOVICH,
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JOHN BOYKO,
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Great Lakes Steel Corporation,
Ecorse, Michigan.

S. C. COZAD,
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Great Lakes Steel Corporation,
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MAX A. SCHUTZ,
Structural Engineer,
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Ecorse, Michigan.

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Republic Steel Corporation,
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Systematic

L. J. BRAY

By L. J. BRAY, General Foreman,

and C. E. KEW, Inspector,

Locomotive Shops

BETHLEHEM STEEL CO.

Bethlehem, Penna.

Presented before the A. I. & S. E. Philadelphia Section, Saturday, March 5, 1938

▲ THE Diesel Electric Locomotive is rapidly superseding the steam locomotive as a switching unit and is also beginning to invade the field of the steam locomotive in the passenger train service where high speed runs are desired and where the traffic density is insufficient to justify electrification. One of the major advantages of Diesel electric locomotives in either type of service is its high availability and ability to stay out on the job for long periods of time without refueling or taking on water. High availability means quick repairs when repairs are necessary and, above all, elimination of failures in service, and this means a rigid adherence to that old proverb, "a stitch in time saves nine". Both these requirements for successful operation of Diesel electric locomotives can best be met by systematic inspection and carefully planned maintenance.

In the development of any program of maintenance covering apparatus and machinery of new design, especially when only recently applied to a particular type of work, different methods of procedure suggest themselves and only by experience and discussion will the best program be fully realized. The purpose of this presentation is two-fold:—

FIRST—To outline a program that has been developed to meet certain conditions, and to pass along data covering a number of short cuts and tricks of the trade that may prove helpful to others engaged in the same line of work.

SECOND—To induce discussion on the subject matter so that finally the best solution will become evident.

The rapid rate at which Diesel electric switching locomotives are being placed in service is bound to create numerous schools of thought as to the method of maintenance to be employed. The various manufacturers of Diesel electric switching locomotives, have established, through their service and contact, certain fundamental rules and policies by which users can be guided. The manufacturers of the auxiliary equipment furnished on these units have also set up certain rules for guidance. It should also be appreciated that there are certain regulations set up by the Interstate Commerce Commission which must at all times be adhered to.

It has been found that the suggestions offered by the manufacturers for routine inspection and maintenance form a sound basis for establishing a definite program. They form a definite guide which can be added to, or varied in any manner as the individual situation demands and practical experience dictates. It seems advisable to incorporate in any working program all of the guidance rules furnished, applying to fits, tolerances, wear limits, etc., and to augment these by experience. The frequency of inspection and the fullness of testing is again a question that can best be answered by experience.

In a majority of cases it is necessary to take men accustomed to working on steam equipment and train them in the maintenance of Diesel electric locomotives. It requires patience and persistence to change over the working group to do even the methodical mechanical routine. Experienced maintainers for both Diesel and electrical phases are not easily acquired nor readily trained, unless the men themselves are interested and have a flare for that particular type of work.

Careful electrical maintenance is vitally important in order to keep the locomotives functioning as a complete unit. Neglect of some minor detail or part may cause frequent and unnecessary delays. Rigid adherence to routine tasks on periodic inspections prevents delays and increases availability.

Fundamentally a Diesel electric locomotive is a power station. It combines the generating set with the consuming units, and, because of this, it has grouped in a confined space all the usual operating mechanisms which are normally remote from the source of supply. The unit thus becomes a producer and a consumer of power. It is mobile. It is subjected to far more abuse than its prototype, because of its mobility and the nature of its work. Yet, withal, it functions amazingly satisfactorily.

Switching locomotives, due to their frequent acceleration and deceleration, their frequent bumping into cars while making couplings, and usually the continual

MAINTENANCE of DIESEL-ELECTRIC *Locomotives*

C. E. KEW

movement over switch points, frogs, crossovers or bad rail joints, are subjected to severe service. Because of this, continued close inspection of all Diesel engine and generator base bolts, flexible couplings, and the numerous piping connections must be made. Since all the electrical contactors on a switching locomotive function more frequently than on a high speed unit, and under greater hardship, they must be closely watched to prevent faulty operation.

Another serious handicap in an industrial locality is the constant presence of grit, dirt, or the dust pertinent to the industry. This is a hazard which must be consistently watched and guarded against, and requires frequent changing or cleaning of air filter elements. It is sometimes necessary to add similar air filter elements in front of the engine-room intake to reduce the dirt accumulation and prevent resultant excessive wear on generators, motors, and other moving parts not completely enclosed.

The units serviced are the conventional 0-4-4-0 type switching locomotives having 2-4 wheel motor trucks with clasp type brakes and double helical and semi-elliptic spring-supported truck frames. The superstructure has the cab and power compartments separate. There are adequate fuel and air tanks, and sand storage to permit long operating service and few refueling and sanding delays. An adequate storage battery supplies power for lights, engine starting and control equipment.

The operator's station is equipped with the following:

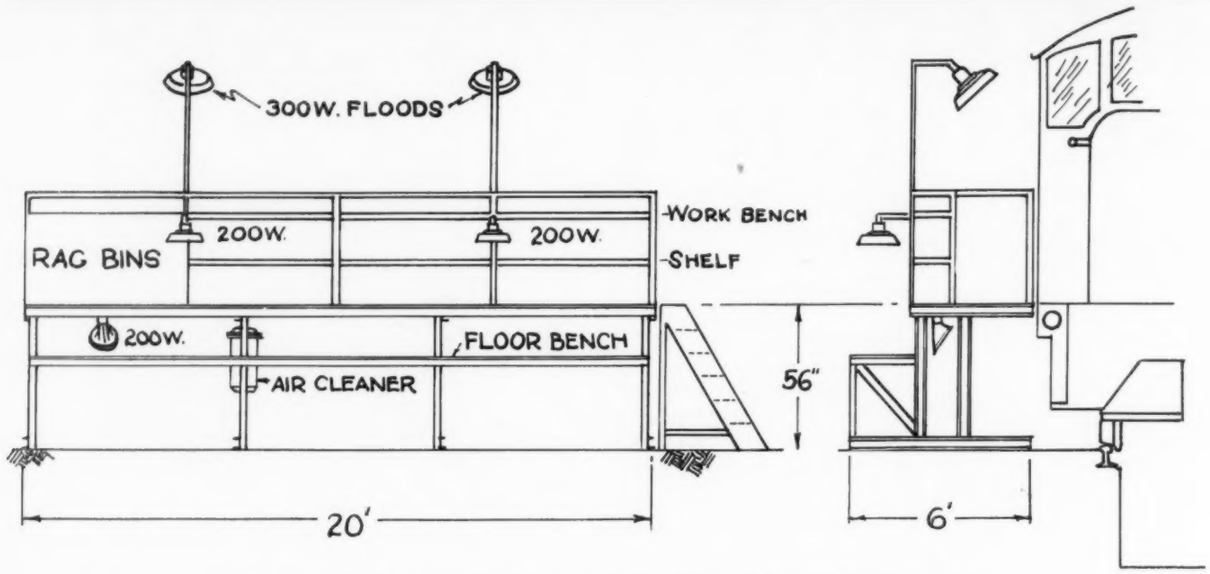
(1) Straight and automatic air brake valves.
(2) Sander and signal valves.
(3) Throttle and electrical control.
(4) Miscellaneous switches for
    (a) Headlights
    (b) Gauge lights
    (c) Motor control
    (d) Engine start
    (e) Fuel pump
    (f) Exciting field
    (g) Cab heater
(5) Instrument panel with
    (a) Air brake gauges
    (b) Engine temperature gauge
    (c) Lubricating oil gauge
    (d) Fuel oil gauge
    (e) Engine Tachometer
    (f) Battery charging ammeter
    (g) Exhaust temperature pyrometer

Before presenting the definite program, a brief outline of the servicing and maintenance facilities available and developed, in order to efficiently carry out the various phases of the schedule, will indicate the normal problems encountered in establishing definite maintenance control.

The facilities are designed for servicing both Steam and Diesel locomotives and include ash pit, coaling station, water treatment and filling station, as well as sand drying equipment and storage tower. The fuel oil storage tanks are located so that fueling and sanding can be accomplished simultaneously. The repair shop, served by a transfer table, includes four pits, a machine tool section, air brake room, tool room, parts storage room, smith shop, welding section and lubricating oil storage and reclamation section, also an overhead crane of sufficient capacity to lift the heaviest piece.

The pits offer excellent facilities for under-frame and truck inspection and maintenance. Steps are provided at each end of the pits, to permit safe and easy access to this section. Since the runway or top of locomotive underframe is about 56 in. above the rail and only accessible by means of gangway steps at either end of the locomotive, it was found that considerable lost time, inconvenience and risk were encountered in doing service work on these units, particularly on the monthly check-up, when Diesel men, electricians, air-men and wipers all sought to do their particular work at the same time. The men had to hang on with one hand, and work as best they could with the other. Because of this, a portable platform and work bench was developed approximately 20 feet long and 4 feet wide with a floor height corresponding to the car runway height.

This platform is equipped with sufficient flood lights for night work, portable light connections, air hose connections; also air filter for removing abrasive material and moisture from the compressed air supplied by the plant system. A narrow work bench runs the length of the upper level and at one end under this bench are bins for clean and dirty rags. A middle shelf between bench and platform floor provides additional space to store tools and materials. On the shop floor



Six air connections located at convenient points and a sufficient number of outlets for portable lamps are features of this work bench.

level and away from the locomotive, another work bench is available the full length of the platform. This provides work space for cylinder heads, etc., where they can be worked on out of the way of the men working on the Diesel or the electrical and mechanical equipment above the car floor. Two of these platforms are used, one on each side of the locomotive, providing adequate floor space and bench facilities for all men working above the car floor. Provision is also made, by the cantilever type construction of the platform, for men to work at the shop floor level on necessary truck maintenance and lubrication.

Another facility is a special rig with tanks for cleaning, oiling and draining the air filter element of the Diesel air intake filter.

This operation reduces the former hand cleaning and oiling time approximately one-half, and is much more positive in its results.

In order to make it easier to work on trucks from the floor level or from the pit, especially at night when extension lights are inadequate, portable lamp stands have been provided which are adjustable from about 30 in. to 50 in. in height.

These stands are provided with 18 in. reflectors and 300 watt lamps which supply ample illumination and allow the men full working freedom.

During cylinder head and piston removal periods, unit injector and portable piston racks have been provided.

These not only permit ready accessibility for necessary maintenance, but also give ample protection to the individual parts. The injector racks are equipped with hood covers to prevent dust and grit accumulations in the injectors during the maintenance period.

Numerous minor implements were developed to meet the needs of certain situations, and which are now routine equipment, such as:—

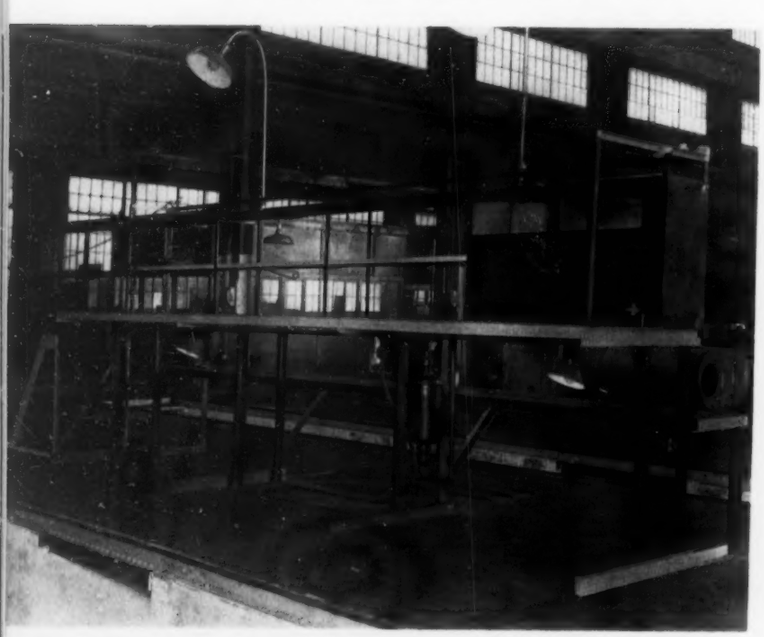
(1) Pans to hold all bolts, fuel lines, fuel oil connections, rocker arms, shafts and bearings from each cylinder head separately.

(2) Wooden plugs to insert in cylinder head injector holes to prevent nuts and bolts dropping into cylinders during head application or other work before time to apply the injector.

(3) Wood piston pins and hammer used when examining piston pins and bearings or changing pistons on rods.

In order to economically perform the various phases

The cantilever type construction of this platform makes it possible for men to work at the floor shop level on necessary truck maintenance and lubrication.



of maintenance involved, it is necessary to have specialized equipment for certain jobs. For all types of Diesel and gas engines, a suitable valve grinding machine with wet grinding attachment and valve seat grinder will make it possible to do the work of cleaning and grinding valves and valve seats in one-third of the time it would take to do this job by hand.

The cleaning of the pistons is done with a revolving steel brush on a flexible shaft.

Cleaning of the exhaust ports in cylinder heads is also done with a flexible shaft machine and a special stiff brush. Thus, whenever possible, special tools and equipment are devised or secured to facilitate the work at hand. This may take the form of jigs or some other equipment, but all being used for the same purpose, to eliminate useless repetition, cut down time, and secure maximum efficiency and availability of the unit.

The adherence to a high standard regarding lubrication is the means of preventing excessive wear and serious and costly delays, with resulting high repair costs. In order to insure trouble-free oils for Diesel lubrication, weekly samples are taken from the crankcase of each unit and tested for the following:—

Viscosity
Acidity
Sludge—when the operating hours are to be extended over 700, or conditions necessitate.
Dilution—with fuel oil.

A daily log is kept of oil additions, and where excessive consumption is noted, or when no additions occur beyond normal intervals, a sample is immediately taken and checked to determine the probable cause of a given condition. This usually results in an oil change and corrective maintenance on the Diesel to prevent further trouble. A log sheet, showing viscosities of all samples run for each engine weekly, is followed to find out the trend of the oil and checks are made as required.

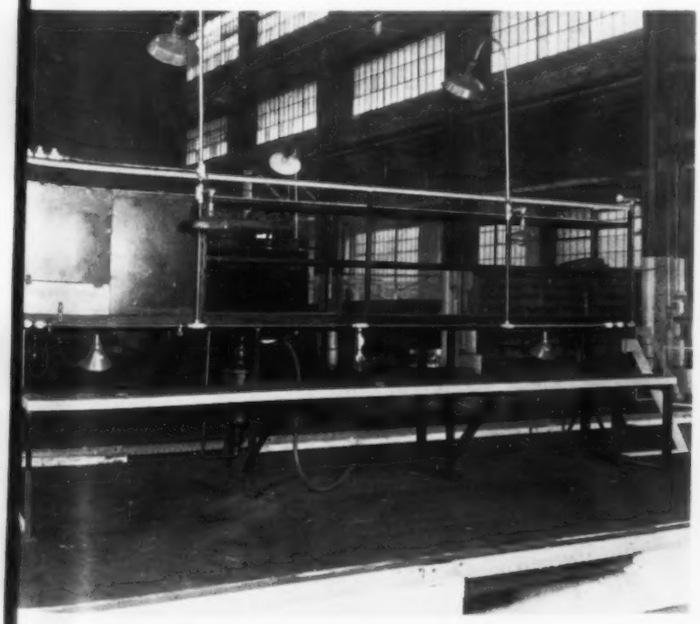
All crankcase oil is reclaimed by a re-refining process. The oil is first treated with sulphuric acid to separate the hard carbon particles, and then allowed to stand for 12 hours. At the end of this period, the carbon has settled to the bottom as heavy sludge, and the oil is then transferred to a tank where diamataceous earth or clay is thoroughly mixed with it. The batch is then pumped into a retort, where while under a vacuum of 28-30 in., the temperature of the oil is raised slowly to about 650°F. The light ends are distilled over to a separate tank. After heating from two to two and one-half hours, the oil is allowed to cool slightly before dropping it from the retort to the contact tank. Here it is again mixed with clay, further cooled, and then passed through a filter press. The resultant oil is then ready for use. It is possible to maintain close control of viscosity on the various grades of oil used.

The normal routine lubricating procedure covers:—

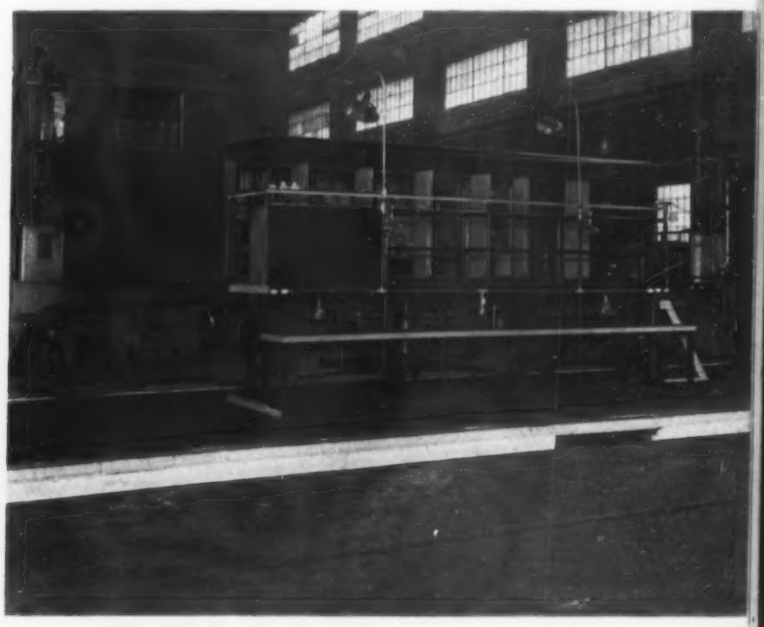
Daily —Checking and replenshing of Diesel crankcase oil, governor, air compressor, journal and truck center bearings.
Weekly —Traction motor sleeve bearings.
Semi-Monthly —Axle motor bearings, main and auxiliary generator bearings and Diesel air filter.
Monthly —Cooling fans, governor and throttle control linkage, fuel pump motor bearings, truck side plates, antifriction motor bearings, traction motor gears and compressor air cleaners.
Semi-Annually—Changing Diesel governor oil.

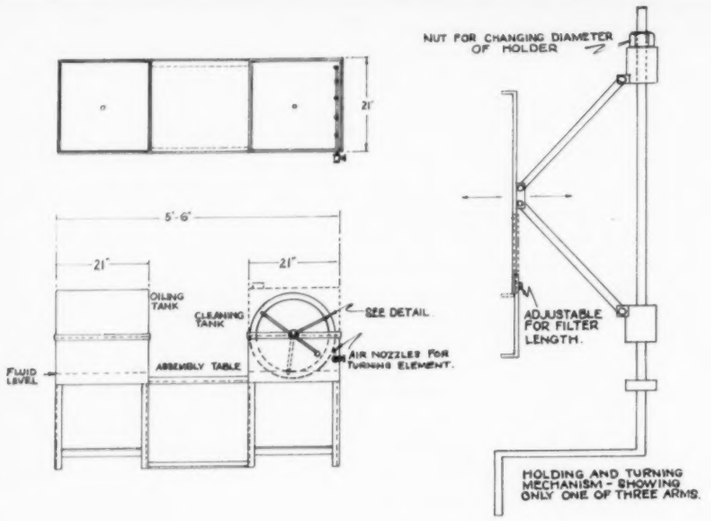
In order to do the normal reconditioning work on

This work bench located on the shop floor level and away from the locomotive provides work space for cylinder heads, etc. out of the way of the workmen.



This view of the platform shows a Diesel electric locomotive in position ready to receive systematic inspection and carefully planned maintenance.





Schematic drawing of the filter cleaning and oiling tanks showing general construction features.

the commutators of the various generators and motors without having to remove the armatures from the units, which in most cases is a lengthy job, the following equipment is used:—

A small commutator grinding tool and commutator stones.

Steel turning tool.

Special hand stones and cleaning compound.

The Interstate Commerce Commission requires an annual high voltage breakdown test of insulation that shall be 1¾ times greater than the normal operating voltage of the locomotive. This test, if applied haphazardly, can be more destructuve than useful. A properly designed testing set does this work without damage to good insulation and yet uncovers any that has materially deteriorated.

The set in use at present consists of:—

Single phase transformer with a separate voltmeter winding.

Single phase induction regulator.

Voltmeters for indicating the exact output.

Combination line switch and indicating lamp.

Circuit breaker.

Safety test handles and leads.

After the ground connection is made, and the circuit connection established, the set is turned on, and the voltage is brought up from zero to the required standard by means of an induction regulator. The voltage is held for the required time, and then dropped back to zero in the same manner. This method conforms to the A.I.E.E. recommendations, and gives a smooth, positive test.

As an added check on the condition of insulation, a portable ohm-meter is used semi-annually and before the annual voltage test. The results are tabulated in record form and an attempt is being made to definitely establish a pre-conception of normal insulation life by comparison of decreasing resistance values.

In the checking of power output and fuel consumption of the locomotives, a water rheostat and suitable fuel measuring tank is used. The load test is of one hour duration at constant Diesel engine speed with recording of all necessary data. These tests are run, one, a week prior to unit shopping for Diesel carbon cleaning, etc., and another a week after unit has been returned to service, at which time all necessary adjustments are made to Diesel and electrical equipment to secure full rated output. This has been successfully used in testing 900 h.p. units.

In order to comply with the Federal ruling on headlights, which specifies sufficient intensity to clearly see a man at a distance of 300 feet, and in order to prevent excessive brilliancy, a number of tests were made to determine just how much light was needed. After each test, a white screen 8 ft. x 8 ft. was substituted for the man, and by means of an extremely sensitive photometer, a reflection value in terms of foot-candles was set up. The average value was determined, and is now the standard by which all headlights are adjusted.

Another necessary adjunct to both mechanical and electrical repair jobs, is an assortment of easily applied and operated wheel and pinion pullers. Almost all electrical and mechanical machinery fits, such as antifriction bearings, shafts, pulleys, couplings and pinions, depend largely for their holding power on either shrinkage or pressing. A system was developed whereby any equipment to be dismantled for the first time was carefully estimated as to pulling equipment needed. These pullers were carefully constructed and after usage were labeled and stored for future use.

In the past, general practice for heating traction motor pinions has been to soak them in a hot oil bath for some length of time, trusting that the desired expansion was enough but not too much. To eliminate this guesswork, a small electric furnace, thermostatically controlled, is now used. The furnace is large

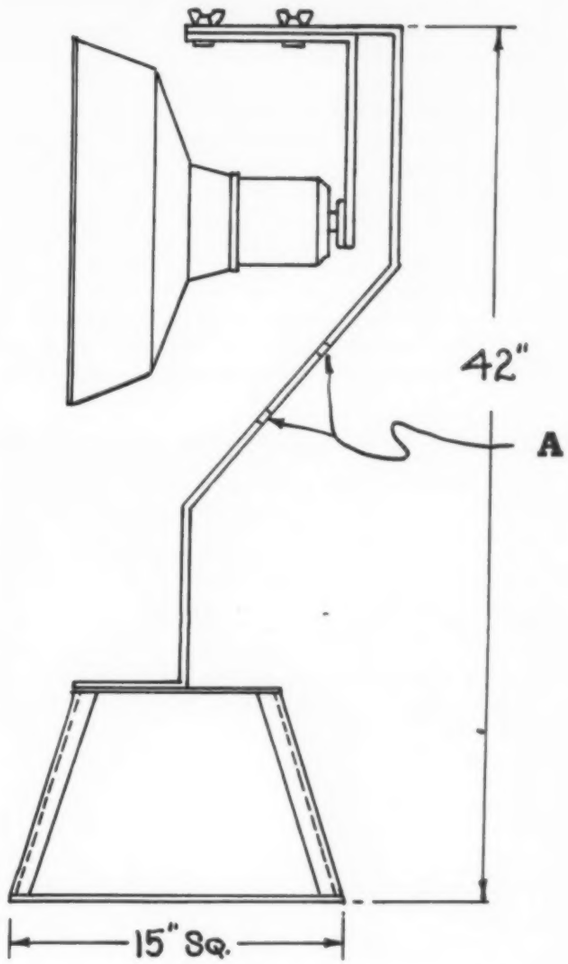
In addition to being more positive in their results, these tanks reduce by half, the hand cleaning and oiling time.

enough to hold two pinions at the same time, and since the relation between temperature and expansion is a definite factor, all guesswork in the replacement of pinions, especially of the new keyless, tapered types, is eliminated.

The newer units all have 600 gallons fuel capacity, and depending on the h.p. rating and load factor at which they operate, they can remain away from their base for three to five days. This presented a new inspection and maintenance problem, but was easily overcome by sending an inspector out daily to cover all inspection of the locomotives, federal, mechanical and electrical. The findings of this inspection are reported at once, and if the defects are of a minor nature they are corrected while the locomotive remains in service. This eliminated the loss of time incurred in bringing a unit to the shop. If the defects are of a more serious nature, such as to be detrimental to the safety of the crew, or harmful to the locomotive if left in service, the locomotive is shopped at once and the trouble corrected.

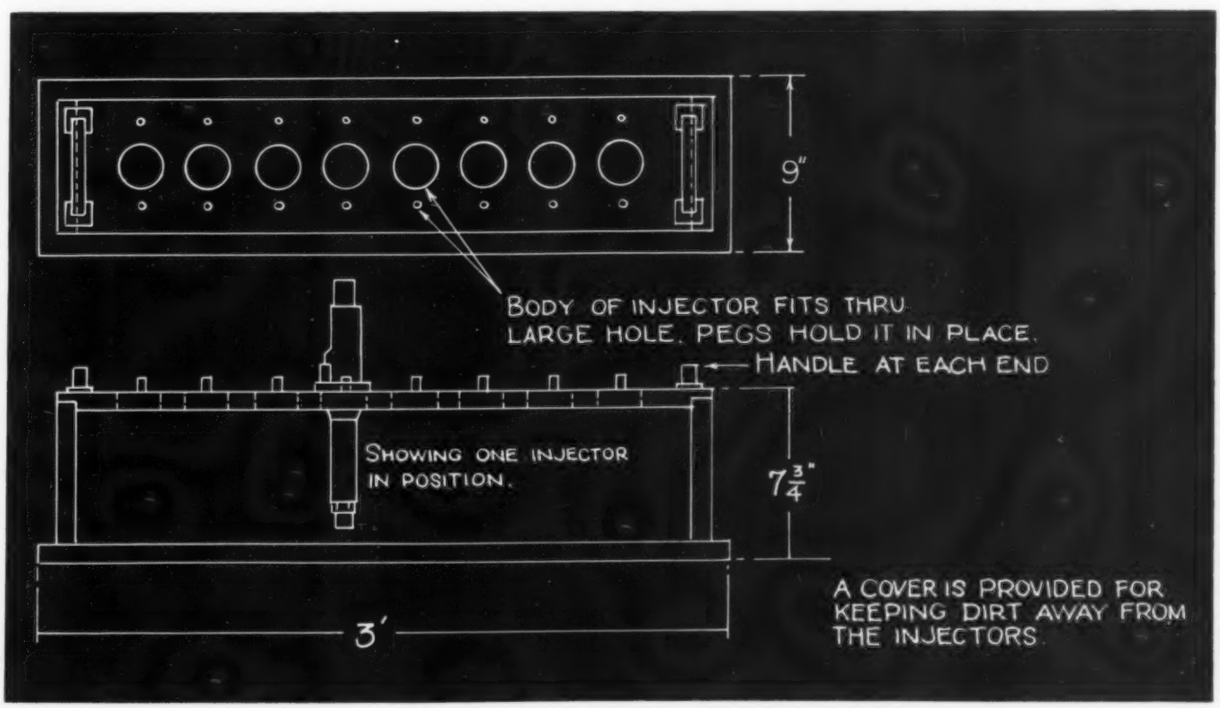
In the past, defects in locomotives have been found to occur in cycles. Thus, if loose engine bed bolts were discovered on one unit, the same could be expected to occur in other units of the type and age within a short time. If one voltage regulator develops a bad field coil, similar developments could be expected within a short period, and so on through the entire list of mechanical and electrical equipment. It is this cyclical occurrence of failures that creates the basis of what can be called "preventive maintenance", since, by working on this premise, it is possible to forestall given failures in other units, thereby reducing repair delay and maintaining availability.

The results of the daily inspections are brought to



When extension lights are inadequate this type of portable lamp (right) is used. "A" denotes point at which brackets may be attached for angular mounting.

Below is shown a diagramatic sketch of a fuel injector rack. These are used during cylinder head and piston removal periods.


9"
BODY OF INJECTOR FITS THRU LARGE HOLE. PEGS HOLD IT IN PLACE.
HANDLE AT EACH END
SHOWING ONE INJECTOR IN POSITION.
7 3/4"
3'
A COVER IS PROVIDED FOR KEEPING DIRT AWAY FROM THE INJECTORS

their final conclusions at the end of the operating month of each locomotive, which culminates in a routine monthly inspection. Unless specifically reported, the Diesel engine is first run to permit checking of lubricating, fuel and water line connections for possible leaks. After this check-up;

The lubricating oil is drained from the sumps.

All lubricating oil and fuel oil filters are cleaned, and the cylinder head fuel strainers checked for capacity.

Cam pockets are drained, specifically noting the presence of any water which would indicate a bad cylinder head gasket or the need of cylinder head tightening.

All exhaust valves are checked and adjusted.

All injectors are checked for throttle adjustment.

All pistons are checked for stuck or broken rings.

On those so equipped, the circulating water heater fuel tanks are replenished when required.

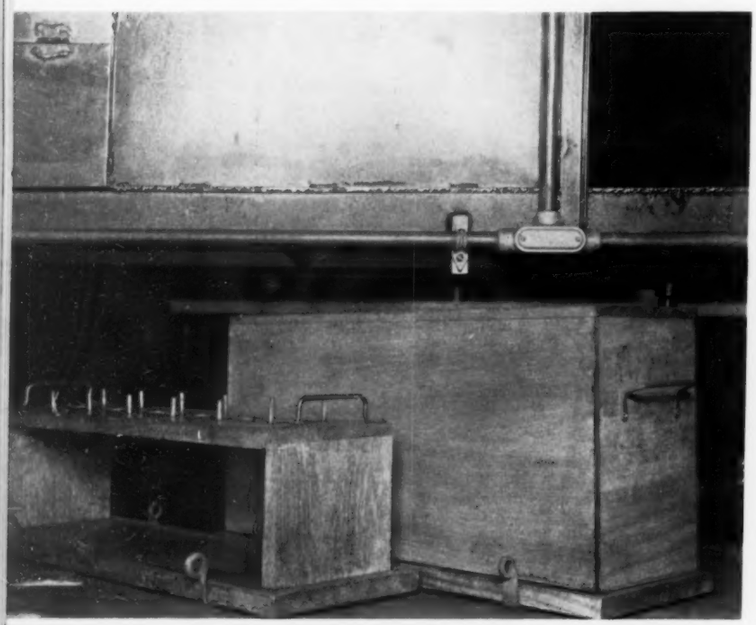
Belt drives are checked for tightness.

At these monthly inspection periods a thorough check-up is made of all air equipment, including brakes and sanders. There are a few maintenance checks and jobs performed quarterly unless necessity changes the schedules; as:—

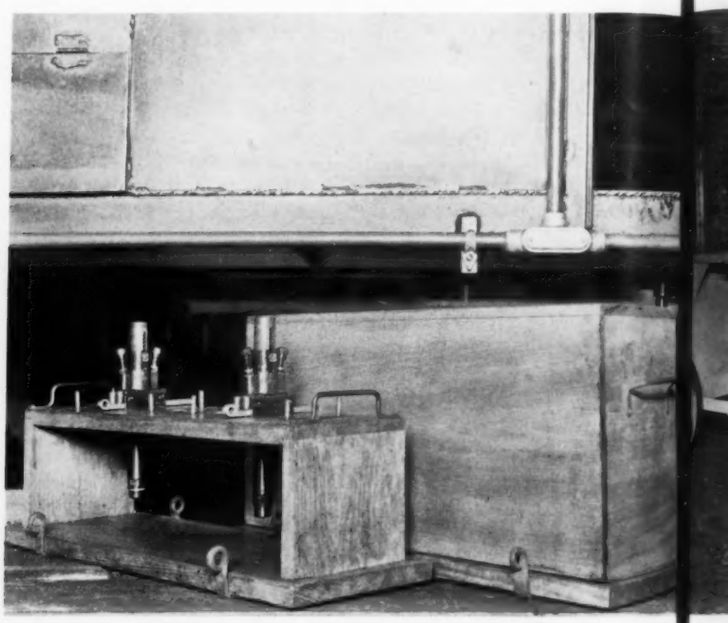
Changing air compressor oil and cleaning of the compressor intake filters.

Wool-packed bearings, such as axle journal, motor axle and some motor armature shaft bearings, have the wool re-arranged to move the glossed packing away and apply fresh packing to the contact area.

The Diesel lubricating oil reservoir is washed down and thoroughly cleaned.



Closeup of fuel injector rack showing protective hood which affords ample protection to the individual parts.



Another view of the same fuel injector rack illustrating the injectors in place.

Broken rings necessitates head and piston removal. Stuck rings can normally be loosened with the application of penetrating oil.

Main bearing jack screws and connecting rod cap bolts are checked.

Cylinder liners and heads are checked for water leaks.

Cylinder heads, cam pockets, and crankcase interior are spray-gun washed.

Fuel and lubricating oil pressures are checked and reset as required.

The fuel suction return line vacuum is reset as required.

The Diesel exterior is thoroughly cleaned, and all hand hole covers checked for leakage.

The water pump shaft packing is tightened, or replaced as required.

The Diesel cylinder blow-off safety valves are cleaned and reseated.

At the end of six months, or the equivalent of 4200 hours of service, a unit is shopped for Diesel checking and maintenance.

(1) All heads are removed, dismantled, carbon cleaned, valves and valve seats reground, return fuel drains cleaned out, and the heads tested for possible cracks.

(2) All pistons are pulled, rings removed and and carbon cleaned. A general check is made of ring conditions as found, also ring groove clearance of new rings installed, and general piston conditions. Piston pins and bearings are checked. If all are apparently uniform, a random piston is selected, the pin removed and bearings and pin are thoroughly examined.

The findings of this inspection determines whether all of the other pins should be removed.

(3) All connecting rod bearings are inspected, scraped if necessary or renewed when needed and checked for size.

(4) Main bearing jack screws are checked.

(5) A thorough examination is made of the crank shaft without removal of same.

(6) A random main bearing is rolled out for inspection and clearance taken.

(7) All crank pin bearings are measured to determine amount of wear, if any.

(8) All cylinder liners are measured at:

(a) 1 in. down from top.

(b) End of ring travel.

(c) 1½ in. below end of ring travel.

(d) 1 in. above air intake ports.

(e) 1 in. below air intake ports both lengthwise and crosswise of engine. Visual inspection is also made to note any scoring or other defects in the liners.

(9) All water manifold connections and packings are checked and tightened.

(10) All lubricating oil line connections are checked and, where possible, lines are subjected to pressure, to clean out any possible sludge accumulations.

(11) All fuel lines are similarly checked.

(12) All exhaust elbows are cleaned.

(13) All pyrometer thermocouple elements are cleaned.

(14) All fuel and lubrication line filters are thoroughly cleaned and checked.

(15) All unit injectors are tested to determine if they are functioning properly.

(16) The governor linkage is checked to develop possible lost motion and correctness of setting.

(17) After re-assemblying pistons, heads, valve mechanisms, etc., the injector and injector linkage are checked for proper operation and travel at various load conditions.

(18) The entire Diesel unit is then checked for possible water, lubricating oil, and fuel oil leaks, and the vacuum reset on the return suction lines for proper operation to prevent dilution.

At this period careful inspections are made of:

(1) Electrical equipment.

(2) Air equipment.

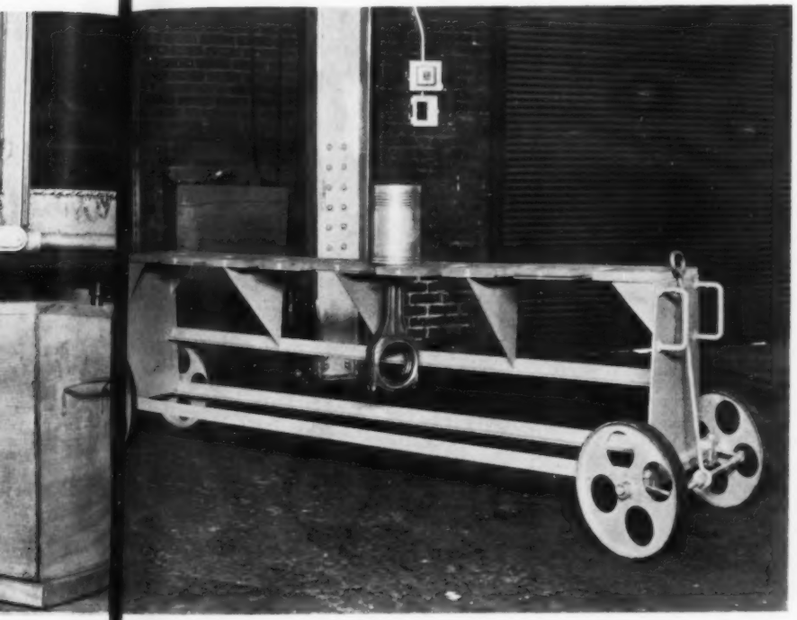
(3) Brake and spring rigging.

(4) All other mechanical equipment, with the necessary repairs being made.

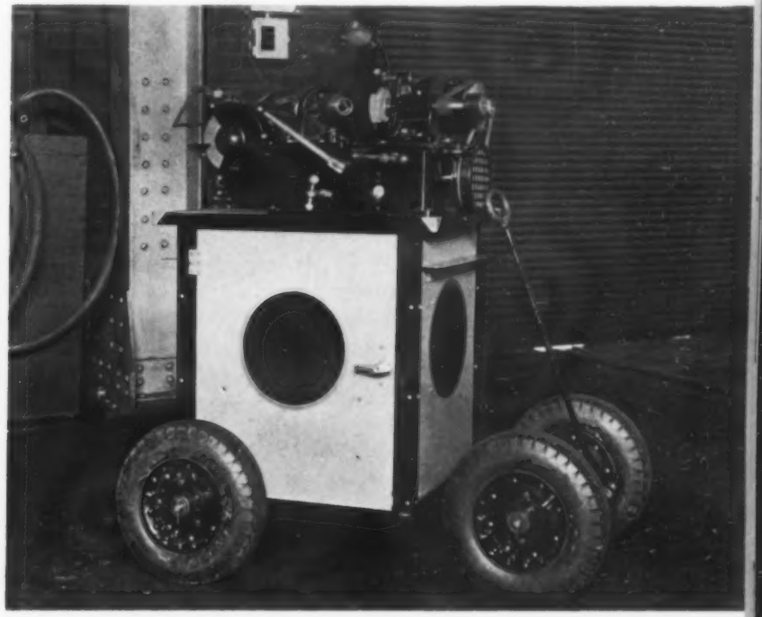
A careful record is kept of the foregoing condition including the amount or thickness of carbon accumulation in exhaust passageways. By comparison of this figure with the known fuel and lubricating oil consumption, a definite balance can be established between locomotive load factor and carbon deposit. From this it is possible to lengthen or shorten the interval between carbon cleaning on the various units, all other conditions being satisfactory to warrant an extension of service.

Monthly routine involves a shop delay of 7–8 hours, with 40–48 man hours, covering Diesel, electrical, mechanical, lubrication and cleaning work.

Annual inspection when no Diesel cylinder heads or pistons are removed, but when the Federal inspection



Portable Piston Rack for storing and servicing pistons during Diesel overhaul.



Portable valve face grinding machine and service cabinet with bench grinder.

and testing of all air and electrical equipment are complied with, involves an 8 hour shop delay with 72–88 man hours covering all phases.

When a unit is shopped for Diesel cylinder head and piston removal, carbon cleaning, valve and valve seat grinding and refacing, and piston ring renewal, 48–56 hours delay on 600 h.p. units, and 56–64 hours delay on 900 h.p. units, with a total of 96–128 man hours are required.

Both the main and auxiliary generators need slight attention other than thorough cleaning, and a careful inspection of commutator, brush wear, and brush pressure. It has been found to be good practice to replace all brushes at once, at the time when the majority are well worn. Then the brushes that still have several months' wear are saved, and used to replace prematurely worn ones at a later date.

At any time when it becomes necessary to remove a generator, for any reason, it is completely dismantled. Every part is cleaned and inspected for defects. This occasion presents the only real chance to thoroughly inspect the main bearings. Since replacement of a bearing is expensive in labor hours, any slightly defective bearing is replaced. Before re-assembling the generator, all parts are well painted with a good insulating varnish. Traction motors are extremely rugged, and as a result require little attention. As far as any daily maintenance is concerned, there hardly need be any, provided a thorough inspection is made at shopping. Motors are kept free of oil, either from the locomotive engine room or from excessively lubricated bearings in the motor itself. They are well cleaned with compressed air, and if the dirt condition seems to warrant it, they are cleaned with a blast of carbon tetrachloride and air. Brushes can present a noticeable item in the cost sheet, unless they are well maintained.

Flexible shaft machine of ½ H.P., 3 speeds and 6 foot shaft having swivel yoke tripod mounting.

After the proper grade of brush has been determined, the spring pressure should be found that gives the best life, and that pressure should be maintained on every brush in each traction motor.

When the wear on wheels necessitates their removal for turning or renewal, all traction motors are removed, thoroughly cleaned, and an armature pulled on at least one for bearing inspection. Commutators are dressed as necessity dictates. Motors that are completely dismantled are painted with a good insulating varnish. Brush holders are filed free of pitting, and broken shunts and bad springs are replaced. If the motor uses sleeve bearings they are checked for clearance, and, if found within operating limits are repacked for use. All anti-friction bearings on motors are checked and repacked with new grease.

The average type of present-day equipment consists mainly of four rotating electrical elements. These consist of an auxiliary generator across which the batteries for starting are floated, an exciter that derives its excitation mainly from the output of the auxiliary generator and in turn provides the excitation for the main generator, and, last, four traction motors that are geared to the axles. This line of functions is controlled by only one governing element; the voltage regulator in the auxiliary circuit. Obviously this element requires careful adjustment and attention. After a voltage setting is once made, it needs no routine maintenance other than to keep contacts clean and free-moving and maintaining tight connections.

In the modern locomotive, the power switch combination is invariably an electrically controlled air-actuated type switch. There are, on any of these various combinations, several items to be checked daily, namely;—the magnet valves for sluggish operation or leakage, the contactor tips for excessive burning and the arc-shutes for the same reason. Buttons for manual operation are provided on all magnet valves, so the task of checking the power switches is a simple one, as, by removing the arc-chutes, all the necessary checks can be made by simply compressing the valve buttons. During the monthly shopping, the air cylinders are thoroughly lubricated with a good grade of control oil, all contact tips are file-dressed and arc-chute side plates cleaned and filled with some type of fast-drying arc-chute cement. Any badly burned tips are renewed, and all connections both on the switch itself (such as tip bolts and shunts) and the connections from other equipment are thoroughly tightened, especially on new locomotives or on replaced parts. Another important item in the control is the reversing switch. The most important daily checks are for signs of burning and lack of lubrication. Burning can indicate three important things:—

(1) That the interlocks controlling the reversing switch are not operating properly.
(2) That the operator is not operating his unit as instructed, i.e., to never reverse the locomotive while it is still moving.
(3) That the fixed contact fingers do not have sufficient contact pressure to carry the required current.

Like the power contactor, the reversing switch can also be easily actuated by hand. At the monthly inspection period, all old lubrication is removed, the drum

is cleaned thoroughly and regreased with one of the commercial grades of control grease. Here again all connections are checked thoroughly for tightness.

Batteries, of the type used for starting purposes only, require very little maintenance other than to keep them well cleaned and properly filled with water. The filling is best accomplished with one of the automatic filling devices now on the market.

Dirst conditions in the various operating locations vary, but experience has taught that the maximum lapse of time between thorough cleaning of all electrical equipment with carbon tetrachloride should not exceed six months. Some extremely dirty localities necessitate more frequent cleansing of the equipment. A small gun made up of copper tubing and fittings, throwing a fine hard spray of air and carbon tetrachloride was developed as the best means of doing this. The process is complete, leaves no unevaporated liquid, and gets the dirt out of the "hard-to-get-to" places in both generating and control equipment.

This same spray gun is the principal tool used in washing the Diesel engine, but using the less expensive safety solvent as the cleansing agent.

One of the prime essentials in proper maintenance is the securing of daily reports from each engine on a standard performance form, as well as the customery federal trip inspection reports by the engineer. These are supplemented with a daily field inspection report by the locomotive inspector.

A definite daily study of these three types of reports, indicating operating conditions and defects, provides a basis on which to plan and perform shop checking and maintenance. When operating faults, either specific or general, are indicated, prompt field inspection and correction often prevent shopping delays. The quick attention to small repairs has saved many major repair jobs. As an example, a voltage regulator on the auxiliary generator that charges batteries may burn out. The batteries may be charged for a day or two at excessively high current and suffer great deterioration. True enough, the engineer should be able to check this on the battery charging ammeter, but the time has not yet arrived when the engineer can be depended upon for such close follow-up. The daily information given in the various reports is transcribed to monthly log sheets,—one for operating data and the other for maintenance data. All operating data is based on either crew assigned hours or Diesel operating hours dependent upon the information desired.

In order to make it easier for maintenance men, by eliminating excessive record keeping on their part and also to insure proper parts application on the various units, a schedule has been made up covering:—

Sander Hose
Light Bulbs
Belts
Brake Shoes
Water Hose
Carbon Brushes

showing sizes or part numbers, unit numbers and location.

For daily field servicing covering fuel, sand, lubricating oil and repairs a board schedule is operated designating the units due to be fueled. This also indicates the units which are due for air filter renewals.

Every three months a definite record is made of flange and tread wear on all units in order to determine possible trend and ultimate shopping. It is also possible from this to reassign units to yard sections where the wear on flanges will be opposite to a given wear and thus secure longer wheel life and higher availability.

In industrial yard switching work where short radius curves are frequent and tracks and roadbed are not new, the average life between wheel turnings is one year. This again depends upon service and trackage and varies greatly in different localities. At the time of wheel turning, when trucks are removed and completely dismantled, the brake and spring rigging pins, bushings, etc., are renewed as required. The journals and motor axle bearing sizes are taken to determine amount of wear. Whenever it is necessary to change wheels on these locomotives, a special jig is used to permit wheel removal without disturbing the axle gear. A 400 ton wheel press is available for this work. Wheel turning is done on a standard wheel lathe. Rolled steel multiple wear heat treated wheels are installed on renewals.

The question of spares must be determined by the proximity of the source of supply. It is extremely desirable to have on hand minor, small, easily renewable parts, both mechanical and electrical, to perform quick repair work. This is necessary to maintain a high availability. Parts that are large and costly, and which require considerable time in removing and installing, can ordinarily be secured without causing additional delay at a given repair period. A study of the normal parts replacement experienced over a few years time will indicate the type and quantity needed. Such items as Diesel piston rings, cylinder head gaskets, fuel and lubricating oil line gaskets, crankcase cover plate gaskets, motor and generator brushes, contactor tips of all types, one coil for each of the vital contactors or relays, and similar parts, indicate the type of desired

High potential testing machine showing panel board, safety test handles and leads, and voltage regulator crank.

quantity spares. A Diesel cylinder head complete with valves and springs, piston, cylinder liner, two connecting rod bearings, voltage regulators, etc., indicate the type of unit spares desirable for emergency repairs that can be quickly made.

A necessary item of equipment on Diesel-powered units is "Safety-Control Apparatus" designed to protect the power plant in the event of:

(1) Low lubricating oil pressure caused by lubricating oil pump or line failure.

(2) Overheated engine caused by low cooling water due to leakage, neglect, sudden system failure or unusual engine conditions.

This apparatus may be applied in a variety of ways effecting the desired results automatically or manually. Individual pressure switches and thermal elements operating warning lights or horns are employed, which then rely on manual shutdown. Electrically-operated trip valves or pressure drop mechanically-operated valves provide instant shut-down. Other methods reduce the engine speed to idling. The exact method employed depends on the service and the equipment. It is important to have safety control apparatus to save Diesel engine bearings, pistons, liners, rods, shafts and other parts, also the resultant shopping delay and maintenance expense involved in this type of failure where no protection exists.

An interesting side light of the working phase of this program is the fact that despite an increase of 315 per cent in total engine hours operated, over a period of ten months, an average availability of 98 per cent was maintained.

It should be borne in mind that any program or schedule of maintenance is subject to the frailties of human nature. It is necessary to be constantly on the alert to improve existing practices, and to prevent loopholes from destroying the benefits of planned routine.

DISCUSSION

PRESENTED BY

F. S. KNABE, Locomotive Repair Shop, Bethlehem Steel Company, Sparrows Point, Maryland

D. M. PETTY, Superintendent of Service Department, Bethlehem Steel Company, Bethlehem, Pennsylvania

G. C. PFEFFER, Electrical Superintendent, Florence Pipe Foundry and Machine Company, Florence, New Jersey

J. A McTAMNEY, Chief Electrician, The Midvale Company, Nicetown, Philadelphia, Penna.

H. B. SPEECE, Bethlehem Steel Company, Sparrows Point, Maryland

H. D. ESTERLY, Superintendent, Electrical Department, Alan Wood Steel Company, Conshohocken, Pennsylvania

F. O. SCHNURE, Electrical Superintendent, Bethlehem Steel Company, Sparrows Point, Maryland

L. V. BLACK, Assistant Superintendent, Electrical Department, Bethlehem Steel Company, Bethlehem, Pennsylvania

L. F. COFFIN, Superintendent of Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

GEORGE WALZ, Assistant Electrical Superintendent, Bethlehem Steel Company, Steelton, Pennsylvania

A. H. CANDEE, Transportation Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

O. J. GILCHREEST, Transportation Department, General Electric Company, Philadelphia, Pennsylvania

P. A. McGEE, Electromotive Corporation, New York, New York

L. J. BRAY, General Foreman, Locomotive Shop, Bethlehem Steel Company, Bethlehem, Pennsylvania

C. E. KEW, Inspector, Locomotives, Bethlehem Steel Company, Bethlehem, Pennsylvania

F. S. KNABE: The program of maintenance as outlined by Messrs. Bray and Kew calls for an overhaul of the engine proper every six months or its equivalent in operating hours. If shopping with its accompanying loss of availability and cost is merely for inspection purposes it is questionable whether or not it is profitable. On the other hand should the unit show a decrease of power as this time approaches and worn parts replaced the delay is justified.

On the aforementioned reconditioning periods nothing has been given on records of replaced parts. I am of the opinion that if a record of wear of the various essential parts was kept a relation between hours of operation and wear could be established. This relation should prove of value in anticipating future repairs so that the periods between overhauls could be lengthened and thereby increase the availability of the unit.

The system as outlined by Mr. Bray is being followed as conditions permit in the Maryland Plant of the Bethlehem Steel Company and so far has proven very satisfactory.

D. M. PETTY: I don't know that there is anything that I would want to add to the technical side of this discussion. I feel that the boys have presented quite a problem. As Mr. Bray stated in the beginning, one of the things which will be of greatest benefit to us all is an open discussion on many of the points that may be debatable.

I was glad to see Mr. Knabe raise some very interesting questions. I am sure I don't know the answers to them. I hope somebody does. There is just one thing I want to emphasize in this discussion and that is the question of availability and the speed with which inspections and repairs can be made or must be made if Diesel units are going to prove successful.

The only way that a unit of this type can make a proper earning on the investment is to keep it in service. I feel that a good deal of money can well be spent in saving hours of operation. We have to bear in mind that a unit of this type costs in the neighborhood of 2.5 to 3 times as much as a steam engine and

it must do a good job to justify its cost. Availability, in other words, is the whole story.

There is one other thing in this connection that must also be borne in mind which I don't believe was mentioned specifically and that is that the shop program of maintenance must be so laid out that the repair work including inspection is done at a time when the locomotive is not needed for this service, which means in full operation—Saturday afternoon and Sunday and at night. There isn't any other proper time to do that kind of work. Of course, when the complete complement of units are not required, you can afford to shut a unit down in the day time—you would have it down anyway, but you could simply run it into the shop for work.

It is those kind of things which improves the availability and increases the ability of the unit to earn money that you are interested in, and is the thing you must constantly strive for.

As to operating cost, I don't think that is a subject which can be brought into this discussion. I feel that limiting the discussion to a program of maintenance is a very good idea and I merely wanted to emphasize the point that regardless of whether a repair job costs one dollar or twenty dollars, that is of relatively minor importance. The important thing is that the unit must be kept on the job.

It is quite similar, and I feel that it is only natural that steel mill engineers should look at a Diesel unit the same way that they look at a blooming mill. It must be kept running, because, when it shuts down, everything else shuts down and we never think of shutting a mill down to do inspection. If we don't have a group of repairmen that can keep the mill running right through, it is time we get other repairmen. We don't throw the mill away. That is the answer to the use of Diesel locomotives in steel mills.

There is another point or two that I think is of general interest. The question of sharp curves and corners as some people call them, in our tracks makes the Diesel unit a very applicable unit because of the flexibility of its trucks—but the wear on wheels in certain departments will be much greater on one side than on the other, so you either have to turn the unit around or shift it to another part of the plant to keep the wheel wear balanced. I mentioned this not so much for that particular point, but so as to bring out the fact that it is the watching of those little things that is going to make the Diesel unit a success in our steel plants and in industrial plants in general.

Now the question of dirt. I would like to mention that specifically. While the intake air to the cylinders is screened, as was shown in the paper, it is also probable, or we will find it probably advisable in some locations to go even further and screen the air going into all parts of the unit, but all that gets back to the same question, and that is—how much more will a thing of that kind, or how much will a thing of that kind improve the availability of the unit? If it will materially improve, or if we find the unit has to be taken out of service too frequently, if you don't have such an air-screening device, then it will be put on, because it will be a good investment.

I am very glad to see such an excellent turn-out tonight, and I hope we will have a good free open discussion on the points involved, because I do think there are many of the electrical fellows here that will probably have something to say whether or not it is going to be possible to maintain the proper brush pressure on the brushes on the motors and generators, but there is little difference between this kind of unit and a mill in general, and that is that you do have a man looking at this thing every day and if it is found advisable to go to all these little niceties in checking brush tension and all those things, we will do it because it will be found a paying investment to do it. If it isn't found to be necessary, it won't be done, just as you don't do it in a great many installations in your mills and shops—places where a shut-down on a motor doesn't affect anything very seriously, the maintenance and preventive maintenance is not carried to the same extreme as you carry on the other motors where the shut-down penalty is great.

So that no matter how long or how much you discuss this question of maintenance of Diesel locomotives, it gets back to the point that the final result that you are driving at is availability, and our present experience indicates that if you do a good job in that, that your repair costs will also be low. That is one of the fortunate things. Those two things seem to go together.

G. C. Pfeffer: I enjoyed Mr. Bray's paper very much. There are several questions I would like to ask Mr. Bray. First, what grade of fuel oil do they use to get the best results? Second, Mr. Bray spoke of failures running in cycles, can he account for this fact? Third, about the air filters, are they of the conventional steel wool oil treated? Fourth, are the contactors electrically or air operated?

J. A. McTamney: With reference to dirt, I agree with the authors that dirt is an enemy of locomotives, particularly the internal combustion type where the cooling fan draws dirty air into the engine compartment.

Do you provide any means for baffling this dirty air from the engine? Do the engineers or operators of locomotives come under the department having charge of repairs? Also, are the engineers responsible for any cleaning of the locomotive?

H. B. Speece: I would like to inquire about the life of these generators.

H. D. Esterly: Mr. Bray spoke of 98 per cent availability. How would he compare that with the hours of electrical repair work?

F. O. Schnure: I think that Mr. Bray has given us a very good outline to follow in the maintenance of Diesel electrics. Mr. Petty has mentioned the fact that our sole aim is to keep these engines on the rails and working. Now, to do that from an electrical standpoint, we must have parts available for replacement, and the question is, how much stock, which in our case could easily reach a figure of $10,000, should be carried? We are advised by one manufacturer of Diesel locomotives that they can ship parts within twenty-four hours. If this holds true for all Diesel makers, then our stock of parts can be held to a minimum until experience dictates those to be kept

on hand. However their part recommendations seem to cover everything from the headlight to the rear coupler, so I really think they, too, doubt this promise.

Our responsibility to the management is therefore two-fold, first, to keep the engines running and, second, to keep the investment in spare parts at a minimum. At the moment we are inclined to trade a little on the expected life of armatures, field coils, commutators, etc., and carry only those control parts that require periodic replacement.

L. V. BLACK: I was more or less gratified while listening to the paper being delivered tonight, in that there was much less said about the electrical parts of the locomotive than was said about the mechanical parts. In the remarks following the paper I have heard more discussion on the electrical end, than on the mechanical end. I think the percentage of the paper devoted to the electrical troubles as against the percentage of the paper given to mechanical troubles will probably bear out the actual experience in troubles you can expect electrically and mechanically.

The question in my mind relative to maintenance and availability of the locomotive is, how much time and labor is involved in performing some of the anticipated breakdown jobs such as removing and replacing couplings, pinions, etc., and also how much of the locomotive must be disassembled to make repairs to inaccessible parts?

L. F. COFFIN: Mr. Bray and his organization are certainly to be congratulated for having developed such a constructive maintenance program for Diesel electric locomotives. There is no question but that they have set a mark for everyone to shoot at.

Being an internal combustion engine, the Diesel locomotive uses three items for power—air, lubricating oil and fuel oil. The proper preparation, cleanliness and quality of these three elements will effect materially the life of the internal parts. The proper air conditioning has been and is being given more consideration. The re-refining of lubricating oil at regular monthly or bi-monthly periods is well covered by Mr. Bray and includes investment that undoubtedly was fully justified. I would like to call particular attention to the importance of testing and checking the receipts of fuel oil so as to be sure that carbon, sulphur, etc., are held to a minimum.

The wear on flanges referred to by Mr. Bray was also experienced in our plant on the installation of twelve Diesel electric locomotives now operating. As soon as this developed, we equipped all these locomotives with flange oilers and since their installation, the wear on flanges has been greatly reduced.

The figure of 98 per cent availability referred to by Mr. Bray is a most commendable figure. I would like to ask exactly how availability is figured. If a locomotive is idle due to no schedule being provided and repairs or inspections are made during that time, is this repair time counted in as non-available time.

The daily reports referred to by Mr. Bray constitute an excellent record. It is apparent that if complete records in convenient form are available for all parts requiring maintenance, including oil renewal, an intelligent diagnosis of repair schedules can much better be made.

G. WALZ: I simply cannot commend Mr. Bray too highly on the thorough and most able manner in which he is taking care of the maintenance and repairs of these Diesel-electric shifting locomotives at the Bethlehem plant, especially emphasizing those ingenious special tools which he has designed and built for making repair work easier and cheaper, and the special forms which he has prepared for religiously keeping track of every minute detail connected with the work of keeping these machines at all times in a first-class operating condition.

We have at the Steelton plant of the Bethlehem Steel Company, three electric locomotives, used for shifting service. One of these is a gasoline electric locomotive, which we have had for about five or six years. The other two are very modern Diesel-electrics, which we have only had since sometime during last summer, so that they are comparatively so new that we have not only had very little trouble with them, but that we have not had enough time to get much information on the life of most of the parts of these machines. Speaking, primarily, of the electrical equipment of our locomotives, which is the only part with which I am personally concerned, I might say, that so far as the spare part policy, which has been discussed here this evening at such great length, is concerned, our policy at Steelton has approximated very closely that of "Don't buy anything", and strange to say, we have been able to get away with this very nicely, for several reasons:—

First:—Because the entire plant has been running at a somewhat reduced rate of operation, so that delays were not nearly as expensive or important as they would be at times when the plant is operating at somewhere near full capacity.

Second:—Because I have found that the electrical manufacturers have done a really magnificent job in building and installing the electrical equipment, which they have put into these locomotives, in fact, I cannot help but most highly commend the electrical manufacturers for the nearly fool-proof and really battleship type of construction, which they have put into this equipment, and which, because of this has confined all of our electrical troubles to those of the very minor type. I feel in this respect that we steel plants are now reaping the benefit of the many years of experience which the large electrical manufacturers have received from the building and operation of electric locomotives in main line railroad service, even though there is quite a difference between this service and that of steel plant shifting service.

Third:—Because we were forced to do so, for economic reasons—for the gasoline electric locomotive was received, as I recall, in 1932, when we had practically no money to spend on spare parts, and since then we have been very much limited in making expenditures for spare parts, unless they were absolutely indispensable.

A year or two ago, we almost lost our gasoline electric locomotive through a rather peculiar accident. It was running along one branch of a Y track towards the main stem, at the same time that another small gasoline-driven track repair locomotive was running along the other branch of the Y towards the main stem, when the large gas electric ran over the small

locomotive at about the intersection, just about like the Queen Mary would run over a small tug. The wreck caused about thirty gallons of gasoline in the tank of the small locomotive to catch fire, and to burn directly under the main tank of the gas electric locomotive, which had several hundred gallons of gasoline in it. Fortunately, the gasoline in the small tank burned itself out without the gas in the large tank catching fire, which was the only thing which saved the large locomotive from almost total destruction. A very remote possibility of such a thing happening to any of our Diesel-electrics is another reason why we prefer them to the gasoline electric type.

We had one other peculiar breakdown in the engine of this locomotive, which can hardly happen in those of modern present day design. This trouble was caused by a leak developing between the water cooling pockets of the engine casting and one of the cast iron cylinder heads, due to the wall of the cylinder head rusting through, while the locomotive was standing still and the locomotive continued to stand long enough to allow this leak, even though it was rather small, to almost fill the cylinder with water, so that when the engine was started, the piston pushed the head out, wrecking the engine. This cast iron head was then replaced with one made of aluminum, which has permanently eliminated the possibility of any similar trouble occurring again.

Whatever measure of success, which we may have had in the maintenance of these locomotives, has been due entirely to close, systematic, experienced inspection and the time-honored "Stitch in time" principle, which we apply to the maintenance of all of our steel mill electrical equipment.

A. H. CANDEE: I would like to congratulate Mr. Bray and Mr. Kew on a very fine paper. They have tackled this from a scientific standpoint that very few operators have taken the trouble to go into. This is rather refreshing because in roaming the country and looking at Diesel operations here and there we find that very few tools or facilities are provided for maintaining Diesel locomotives.

Most of the comments tonight have been on the electrical end. I think the reason for that is probably because any old engine can run a locomotive, but it takes pretty good electrical equipment to stand the gaff of going over poor track rail joints, crossings, etc. However, I think that the electrical equipment can be over-maintained. Normally it doesn't require very much maintenance. You replace brushes and parts, keep the contacts free and clean, and the rest doesn't require very much attention. I was just a little bit disturbed about the mention of high pressure air and tetrachloride for cleaning out motors, because there is a possibility that, unless it is handled carefully, the high pressure will damage the insulation, I presume however, that it is handled carefully so that it does no damage.

There was no mention made of dipping of the armature. Of course, it is early in the Bethlehem Steel operation to consider that, because they do not have to be dipped and baked for four or five or six years, but eventually, because of the extreme vibration which these locomotives get, and the service heating and cooling, the coils loosen up so that every five or six years it is desirable to take out the armatures and fields and dip them and bake them so as to tighten up the insulation.

O. J. GILCHREEST: The thoroughness with which this subject has been covered tonight reminds me of the thoroughness with which Mr. Petty presented a paper a couple of years ago on the subject of Diesel electric locomotives. I am sure you will agree that there is little to be added on the subject of maintenance that was covered so ably tonight by Messrs. Bray and Kew.

Some years ago when we were introducing the Diesel electric locomotives and claiming high availability, I would approach people and talk in terms of 7,000 or 7,500 hours and I will have to admit that I believe some people thought I was somewhat optimistic on that point, but I am glad I can look some of the same people in the face tonight and have them exonerate the statements I made. We were talking in terms of 83 per cent, and they are realizing 98 per cent.

P. A. MCGEE: I would first wish to thank you for the invitation to come here tonight and to congratulate your section on this well attended meeting to consider a subject which is becoming of great interest to both steelmill inter-plant transportation and railroads in general.

Mr. Bray and Mr. Kew have made an excellent presentation of the systematic maintenance methods which they have developed for Diesel electric switching locomotives. Operators of this type of power I feel sure will be greatly interested in the simple but complete records which the authors employ in following the performance of the various units, as well as in the tools, platforms and facilities employed in their maintenance routine.

The value of their program of systematic maintenance is represented by the availability of the locomotives which they state is 98 per cent. This high availability is explained by the short periods out of service for monthly and semi-annual inspections, which periods are eight hours and forty-eight hours respectively.

The nature of the work performed during the eight hour monthly and forty-eight hour semi-annual inspections was explained in considerable detail, and there is little doubt but that the procedure adopted will insure that engines perform properly and deliver their rated output.

Mr. Petty's remarks on the maintenance procedure employed by the Bethlehem Company represent a very valuable contribution to the paper proper. Mr. Petty stressed the desirability of maintaining the Diesel switchers in constant service in order to get a maximum return on the investment in their locomotives. When it is appreciated that a Diesel locomotive normally represents a minimum saving of about $2.00 per hour over switching power, it will be understood that the most important index in the operation of Diesel power is its availability. In other words, a maintenance organization should be established to

obtain as far as possible continuous use of the locomotive. It may even be desirable to maintain Diesel locomotives during unusual working hours such as with weekend shifts and night shifts in order to insure that the locomotive is ready when the work is available. The importance of high availability with their inter-plant motive power is apparently well understood by the steel mill industry since the locomotives are practically a part of their manufacturing process and are just as important as any other part of their steel mill.

Railroads which are accustomed to the normally low availability of steam switching power at times find it difficult to appreciate the desirability and possibilities of the high availability of Diesel power. I believe, however, that Messrs. Bray's and Kew's papers outlining in detail a systematic maintenance procedure should be very valuable to railroad users and potential users of Diesel power. It is true that Diesel power must be inspected and maintained in a regular and expeditious manner in order to insure maximum economies with its use.

I am very pleased to note that you have at your meeting tonight a large and representative group of men from the Reading System which has recently become actively interested in the employment of Diesel switching power.

D. M. PETTY: I would like to take a load off Mr. Bray on just one point. I would like to expand a little bit on the question that Mr. Coffin raised as to the availability and as to the question whether or not the inspection and other routine work is done on units on night turn or Saturday and Sunday.

The point that I wish to make in that connection is that if the locomotive is not needed at night, and if it is not needed on Saturdays or Sundays, that is the time when all this routine work must be done. If there are days when a unit is not needed on day turn that work could be done on that day turn, it certainly would be throwing money away to shut a unit down on any day turn when it is needed, and so long as your plant operates in such a way, and most plants do, that you need less units on the second trick and on the third trick than you do on the first trick, then it just becomes a matter of routine to do all the work that can be done on that second and third trick so that the unit is available when it is needed.

So much for that particular point. I was glad to hear Mr. McGee comment on the hours which we have allocated and which is our standard practice for doing certain of the work as outlined in the paper at those inspection periods. I am always looking anxiously, everybody else is I presume, for somebody else that is doing a better job than we are doing on any of those points, and if there are any gadgets or any short-cuts or any methods that you can employ to speed up any of those operations, it is well worth while. We found in a great many things that if you really sit down and put the thing on a regular football play by play system, there are many things that can be accomplished in much less time than is considered standard practice. I wonder sometimes whether the idea of standard practice and standard custom isn't one of the most dangerous things we can build up in a plant.

The thing to repeat is not only the 46 hours that is required for doing a certain job, but also the man hours which indicate the number of men that are used on the job, and the object of the various bench devices, is so that a greater number of men can get without being in each other's way. If you can put enough men around a thing you can do the whole job in one hour, providing one operation doesn't fall on another. But the point I want to make is that the various jobs must be done so as to keep the unit out of service the least number of hours.

L. J. BRAY: I am going to take up the specific question that was asked in the beginning of the discussion and will then turn the balance over to Mr. Kew, and that is the question asked by Mr. Knabe as to the justification for shopping a unit every six months or as pointed out every 4,200 operating hours. The 4,200 operating hours may occur in six months during busy periods or it may not occur for nine or ten months during periods of low plant operations as at the present time. The justification of this shopping is the development of full rated power output from the low power figure that exists when the Diesel is choked up with carbon. We have found that units get sluggish and "don't seem to pull the load" to quote the engineers who operate it, and we listen attentively to the engineer because he is on the throttle day in and day out. He can tell a little bit quicker than the shop when the unit is not up to standard. As mentioned we have planned for the testing of the units once every six months, just prior to the scheduled carbon cleaning. If the power output is approximately maximum and the unit is functioning properly it can remain in service longer than anticipated, but if the output is off 5 to 10 per cent or more and there is nothing that can readily be done, either mechanically or electrically, to bring it back to the full power rating, the unit will naturally be shopped.

There are times when the auxiliary generator belts slip and proper functioning of the equipment is then not possible which necessitates prompt shimming of the auxiliary generator or even installation of new belts. There are other jobs of this nature that can be done to bring the unit back to full power rating, with very little delay or loss of availability. So far the system of taking units out every 4,200 hours has justified itself both in the increased efficiency of the unit and the correction or renewal of parts that would otherwise not have occurred until failure, when the resultant failure might have been far more serious. Careful records are kept of the wear on all moving parts, to develop planned routine in the replacement or conditioning of the unit. While we have not made an actual test, after carbon cleaning, to determine the factual increase, we know from observing the operation of the unit over a period of a week, not only from the inspections made, and Mr. Kew inspects the units daily to determine the operating characteristics, but also from the reports of the engineers in handling the various loads in the plant, that a definite power improvement was made.

So far, we are still in the experimental stage, any-

thing that we do is not the last word in what we hope to do, because frankly every group of maintenance men involved in maintaining this type of equipment will have different ways of doing it. They will be able to give us information, and frankly, that is what we want. We hope to get from a discussion that develops here tonight pointers and ideas that will enable us to do an even better job than we have done so far. The equipment is new, and our availability factor may be somewhat influenced by that, but we do feel that our own efforts have helped it in a small measure.

C. E. KEW: Gentlemen, Mr. Petty brought up the question of air filter screens on locomotive engine room air intakes. Various industries, due to the nature of their products, have a vast amount of dust in the air surrounding them at all times. Most of these dusts are of a nature harmful to both mechanical and electrical equipment. Therefore, if they can be kept out, the whole unit is better off from a wear standpoint. We are trying such a device on one of our locomotives as an experiment, and in the first week of operation alone over two pounds of accumulated dirt was removed from one of the screens. We are pleased with the results to date if only for the cleaner engine room that results from the application. All of the air filters in use on our locomotives are of the copper wool type.

Mr. Black was quite right in his statement comparing electrical to mechanical service. So far a great deal more time has been given to the servicing of the mechanical equipment. However, when the electrical equipment is a few years older the time needed to re-service it will materially offset the present difference. Most of the control equipment in service today is readily available for easy maintenance, but the main generators and traction motors, mounted as they are, are much less available, but being more rugged need less servicing.

Brush tension checks are not made every day, nor are they made each month with an actual spring balance in use. I think it almost needless to add that an experienced maintainer develops a sense of proper tension in his finger tips.

As Mr. Candee has stated, over-maintenance is one of the main electrical troubles today. This statement is in direct line with our policy that so long as a piece of equipment is functioning properly, leave it alone. To see that it is functioning properly is the main duty of the travelling inspector, for he can very easily observe operation when the unit is in service.

In periods of twenty-four hour service, federal inspections are made at a lunch or shift-change period to avoid unnecessary delays.

As to our availability figure, we base our percentage directly on the hours that any unit can actually be used. Time taken for repairs, whether made at a lunch time or done in the shop, is all deducted, from the actual monthly hours.

The question of man hours of labor compared to shop delay hours was brought up. We normally assume a shop delay of seven to eight hours for routine monthly inspection. If the inspection is an annual and no engine parts are removed we have found that from seventy-two to eighty-eight labor hours are necessary. However, if a unit has a piston and head removal such as was outlined in the paper, forty to sixty shop delay hours are required for a 600 horse power unit, and fifty-six to sixty-six delay hours for a 900 horse power unit, with a total of ninety-six to one hundred-twenty man hours of labor involved.

We use a number two Diesel fuel oil in all of our locomotives, and we make a practice of obtaining a laboratory analysis of a sample from each car load. Our highest fuel oil consumption rate varies between seven-and-a-half to eight gallons an hour. This figure depends entirely on the type of service and the actual percent-demand-per-hour for the locomotive.

In answer to Mr. Pfeffffer's question, I can safely say the main power contactors in use today are of the magnetically controlled, air-actuated type. While most of the auxiliary contactors are of the straight magnetically operated type. As for the life of contactor tips, I would say that it depends entirely on the service to which the unit is subjected. For example, if the unit does heavy switching service in which frequent stops are made the contactors must break fairly heavy currents, while on the other hand, if the pulls are light and the trips long the contactors break only light currents and are proportionately longer lived.

Belts seem to be a problem at this time. Of the two types that we have in service at present, the endless belt has given the longest service, with good life up to a year or more. To offset this longer life however, the endless belt requires a great deal more time to install, than the connector types now in service.

To explain the cyclical occurrence of failures I might say that mechanical parts of like physical properties and the same type of applied stress are likely to exhibit common fallacies. Add to this the fact that various units went into service at the same time and operate under similar conditions, and we have the basis for our reasoning. A good example of this was the discovery some time ago of some loose and broken engine bed bolts on one of the units. Close inspection of our other locomotives of like service disclosed similar conditions on them.

A rough estimate of the cost of proper inspection apparatus for a Diesel electric locomotive would be a thousand dollars. This can be classed as low for an investment that is a necessary adjunct to a good maintenance level on expensive equipment.

One or two locomotive manufacturers are now offering twenty-four hour delivery on repair parts, thereby abolishing the necessity for an expensive parts inventory for the user. Nevertheless, to tie up an eighty thousand dollar locomotive for even twenty-four hours with a five-dollar part is false economy, so this leads to the practice of stocking spare parts that can be quickly replaced. Heavier parts for the main generator and traction motors are not stocked because we have learned that usually by

(*Please turn to page 43*)

Radiant Tube

ANNEALING COVERS

By C. H. CARPENTER, Sales Manager

Lee Wilson Engineering Co.

CLEVELAND, OHIO.

Presented before the A. I. & S. E. Cleveland District Section, March 25, 1938 at Youngstown, Ohio and the Birmingham District Section, April 25, 1938

▲ WHEN an engineering innovation has attained the age of some five years and has passed from the conception stage through the experimental models and on to the successful industrial tool, it is of interest to review its history. This study will often disclose the factors and conditions that were present to make the new development a success. Sometimes the underlying causes are only faintly discernible, if visible at all, at the time the initial work is started. This condition has existed during the development of the annealing cover and it is my intention to briefly discuss this development and to emphasize its present importance and latest development.

A glance at the automotive or household appliance fields shows that progress and improvements from the earlier models to the present more efficient units has been due to the willingness of the consumer to sell or scrap the relatively good apparatus for that which offers better satisfaction.

A similar attitude of mind permeates the steel industry, as is shown by the recent statement of Mr. Chas. R. Hook, President of the American Rolling Mill Company, as reported in the Iron and Steel Engineer for January, wherein he is reported to have commented that approximately $350,000,000.00 have been invested by the steel industry in continuous sheet and wide strip mills in the last ten years. With the mills now installed and those building, there will be 27 continuous sheet and wide strip mills in operation in a short time, with an annual capacity of 14,000,000 tons.

This material has required more careful temperature control and surface protection in the annealing cycles. Were all of this material to be annealed under the prevailing annealing cycles in use today and were it to be annealed in a 50-ton annealing cover at a rate of a ton an hour, there would be required some 1600 covers and 6400 bases and inner covers. Running concurrently with the expansion in the rolling mill processes has been a development of the modern technique of sheet and coil annealing.

This technique has called for furnaces with different characteristics than those formerly used and chief among those requirements may be mentioned—

Flexibility to adjust time temperature cycles to the constantly changing deliveries from the rolling department.

Economical handling of materials during annealing processes, providing for the shortest possible accurate annealing cycles.

Protective atmosphere over steel during heating and cooling cycles.

The annealing furnace which for so long remained a standard piece of equipment, unresponsive and static to the changing requirements, has been re-designed to meet the requirements of the dynamic changes of modern present-day metallurgy. The first responsible furnace companies to grasp the probable requirements of the future ten years ago were electric furnace companies, and this is as it should be, for their fellow-engineers were actively engaged in electrification of the mill drives. For this reason, we find the first portable annealing covers designed and applied by the electric companies, and the first with which the author is familiar were the electric annealing furnaces developed by the Westinghouse Electric and Manufacturing Company and first applied on a commercial scale.

In the early years of the last decade, order was commencing to come out of chaos of the emerging science of electric furnace design and really, for that matter, of furnace design itself, for, in that day there was little assembled and reliable information available. These experiences produced a better understanding of thermal insulation, but of especial interest to us was the scientific method of rating resistance heating ribbon. It was not uncommon at first to find ribbons delivering as high as 60 to 90 B.t.u. per square inch of nitrating surface. Modern practice uses 17 to 34 B.t.u. per square inch, depending upon the application.

It is about ten years since the first production units of the electrical type of portable cover furnaces were installed. These units were, of necessity, electric furnaces, because at that time this was the best known method, perhaps the only known method, of scientifically producing an annealing tool having control of temperature distribution throughout the charge and at the same time having control over the composition of the gases surrounding the charge during the entire heating and cooling cycle.

The design of the furnaces built then was about the same as that of the furnaces built now. They had the portable bell, or cover, and on the walls were placed the resistance heating ribbon. Each cover, depending upon the application, had the requisite number of inner covers and bases necessary for the heating and cooling cycles employed. Both the cylindrical and the rec-

C. H. CARPENTER

Presenting his paper before the large number in attendance at the Cleveland district section meeting held in Youngstown, Ohio on March 25, 1938.

tangular shapes were built, the cylindrical design predominating, because the finished product, being of the highest quality, sold for a price that justified the expensive electrical B.t.u. The rectangular furnace was applied largely to high silicon sheet. These furnaces operate at temperatures above 1900 deg. F., usually of a capacity to take from 20 to 60 tons, and require a very special atmosphere.

These electrical furnaces, equipped with an inner hood providing facilities for almost any kind of protective gas over the charge, seemed to offer a large field for exploitation by the electric furnace manufacturer and stood somewhat as a challenge to the fuel engineer, offering for a while a serious competition to the purveyor of gaseous and liquid fuels in a field peculiarly his own. Of course, the factor that held them back was the high cost of the heating unit. This heating unit, as delivered at the furnace, carries with it the accumulated costs of conversion of the energy in the fuel to electric energy.

This fact set many engineers to work to produce a furnace having all of the inherent characteristics of the electric design, but to use the heat of combustion directly at the furnace. The solution of the problem was, we know, the radiant tube.

In passing, it is only fair to acknowledge the contribution of the electric furnace engineers who furnished the idea; developed the principles of the scheme; gave direction to the development of the proper materials for thermal ceramic insulation; developed alloy inner covers; and produced special atmosphere generating equipment. Much of the phenomenal success of the radiant tube annealing cover is due to their pioneer work.

Among the engineers who really grasped the problem and its immense possibilities was Mr. Lee Wilson. He set to work in an experimental way in 1931 to prove the feasibility of his idea of burning gas in a tube in such a manner that the products of combustion would be carried out of the furnace chamber after they had delivered their useful heat through the walls of the tube to the charge to be heated. As in the case of other inventors of practical ability, he assembled the materials close at hand for his initial experiments and performed the experiments in the basement of his own home. Figure No. 1 shows this equipment, which is now in use as a heater in the Lee Wilson laboratory.

As a next step, Mr. Wilson demonstrated his idea to his friend and encourager, Mr. H. W. Theiss, vice

FIGURE 1—Experimental equipment used by the inventor in 1931. This is still used in the Lee Wilson laboratory as a heater.

FIGURE 2—During the early experimental stages this old oil can served as a furnace.

FIGURE 3—This view of the oil can shows the tube welded into the side.

president of the Superior Sheet Steel Company. Here an oil can served as a furnace and a tube was welded into the side of the can, as shown in Figure No. 2. There was an inner lining of sheet material and the annular space between the inner sheet and the outer casing was filled with insulating material. Figure No. 3 shows this equipment lying on its side.

It was not long after this that the first complete unit was built, but there is no picture extant of this installation, however, Figure No. 4 is very similar to the first complete unit, and was installed at the Superior Sheet Steel Company.

Figure No. 5 is another view of one of the earliest furnaces, and was really installed as an experimental unit at the Beech Bottom Plant of the Wheeling Steel Works through the helpful cooperation of Mr. Clarence H. Verwohlt of the Wheeling Steel Corporation.

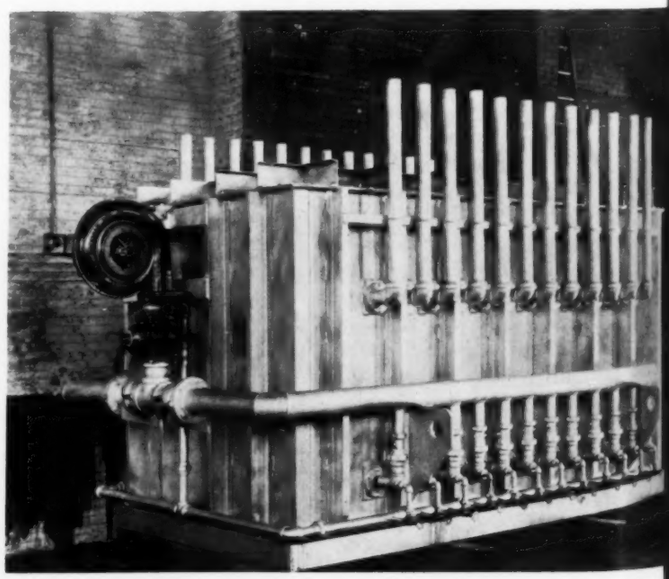
It is interesting to compare these earlier types of portable covers with the 1938 model, as shown in Figure No. 6. These early units did not embrace the inner cover and the intention was to cool slowly under the heating cover. However, the rate of cooling was so slow, even when the tubes were used to blow air through, that it delayed the use of the heating cover too long and the established practice of the electric people was verified in that the heating cover would work more economically when used for heating only, thus conserving the heat absorbed in the walls. To do this, several bases and an equal number of inner covers must be used, but this gives a continuous use of the heating cover and an intermittent-continuous flow of annealed material through the shop.

The intermittent-continuous mass production duties of this type of equipment require the shortest possible annealing cycles, the conservation of floor space, and easy adjustability to the sudden changes of the rate of production, especially during this era of Rooseveltian prosperity and depression.

At the present time the most logical view is that the radiant tube is an improvement over the electrical heating element and possesses two decided advantages, namely, a much cheaper B.t.u. and a better temperature control than is obtainable by the orthodox "on" and "off" electrical heating ribbon system. This will be shown later in the discussion of the vertical tube control and in some curves of actual production records.

It will be noticed from the figures shown, that the application of the radiant tube naturally took the

FIGURE 4—Installed at the Superior Sheet Steel Company is this unit very similar to the first one completed.



vertical position. The originator of the idea had all positions of tubes to select from and chose the one which proved best. The soundness of his idea of burning gas in a tube is testified to by the rapidity with which established furnace companies accepted the principle and started to make competitive apparatus. If a new idea is not worth copying, it will not go far. Aggressive competition arose and helped to establish the radiant tube.

There are, in general, two recognized radiant tubes on the market today, the horizontal and the vertical, and judging by the vastly larger number of vertical tube covers installed, it has been proved the most acceptable to the annealer. Undoubtedly, in addition to the fine temperature distribution obtained, a large part of this success has been due to the simplicity of the combustion system used. The inspirator burner is simple in principle and requires the minimum amount of supervision. It can be readily applied to almost any of the industrial gases that are met with in the steel plant.

In comparison, it is interesting to note the simultaneous development of the competitive tube and combustion system that took place. The tube has a larger diameter and is placed horizontally along the cover wall. It has a long active combustion chamber and a dead leg return to convey the chilling combusted gas away. This combustion system introduces gas and air into the radiant tube in parallel layers without relative motion between the two, which unite and burn between the interfaces of such layers so that combustion propogates at a constant rate throughout a predetermined length. With this system of combustion it is not easy to design a tube to meet the heat requirements of the furnace and at the same time those of the combustion system. The result is a compromise in which the rigid specifications of the combustion requirements predominate. This is seen at the end of an annealing cycle when low heat input is called for. With this system, this result is obtained by turning the gas all on and all off, which alternately produces periods of temperature lag and overshooting at the edges of the charge, exactly as occurs in the electric furnace with the standard control.

With the vertical tube and the inspirator type burner, the furnace engineer designs a tube to fit this specific application.

In the horizontal radiant tube covers there are fewer tubes, but each tube burns considerably more gas. In the vertical tube cover, there are a larger number of tubes and burners, which make for a greater number of control points. This gives a better chance to get equal temperature distribution throughout the furnace and also permits the furnace designer to study the rate at which heat should be liberated at different places along the tube in order to compensate for the varying demands vertically in the cover type annealer.

If the design of the tube and the amount of gas burned per tube has been correctly worked out for the high-fire condition and a throttling type control is used, then the use of more or less fuel, as called for by the thermocouple controlling the throttling valve, changes the height of area of high-heat dispersion. This is of importance as we approach the end of the annealing cycle where less heat is required and the dissipation

FIGURE 5—Another one of the early installations that was installed as an experimental unit at the Beech Bottom plant of Wheeling Steel Corporation.

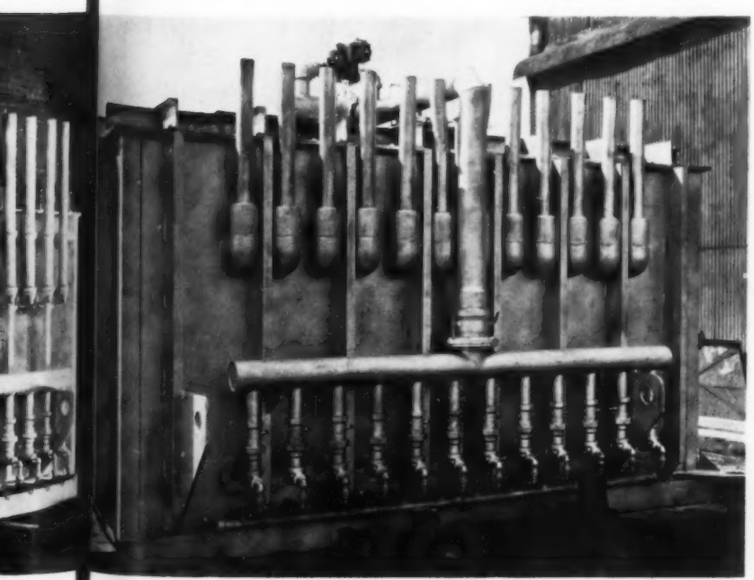
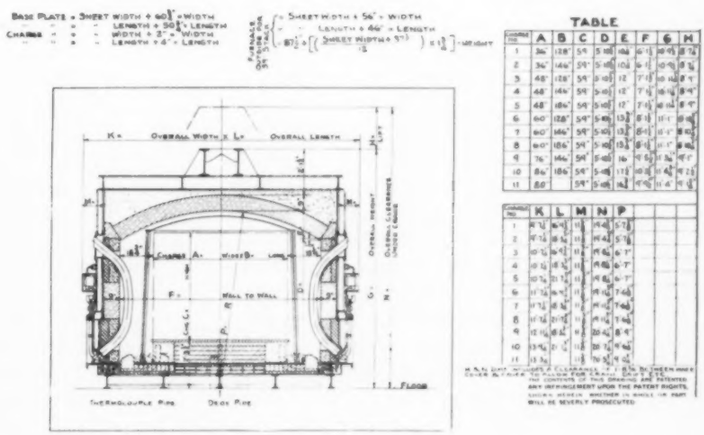


FIGURE 6—Compare the earlier types shown in the preceding views, with the plan of the 1938 model shown below.



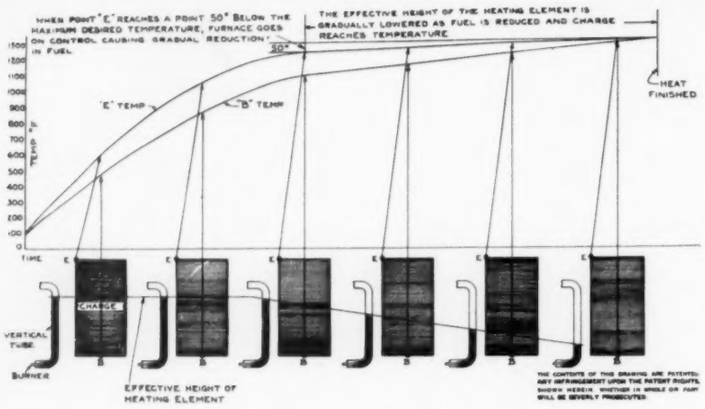

WHEN POINT "E" REACHES A POINT 50° BELOW THE MAXIMUM DESIRED TEMPERATURE, FURNACE GOES ON CONTROL, CAUSING GRADUAL REDUCTION IN FUEL
THE EFFECTIVE HEIGHT OF THE HEATING ELEMENT IS GRADUALLY LOWERED AS FUEL IS REDUCED AND CHARGE REACHES TEMPERATURE
50°
HEAT FINISHED
"E" TEMP
"B" TEMP
TEMP °F
TIME
CHARGE
VERTICAL TUBE
BURNER
EFFECTIVE HEIGHT OF HEATING ELEMENT

FIGURE 7—The automatic vertical control shown in the above chart is designed to regulate the temperature distribution from the top to the bottom of the charge.

the electric furnace and also later in connection with the luminous flame burner.

The entire system is simple; the control instruments are of standard make and design; and there is nothing special insofar as equipment is concerned, that could get out of order.

Another interesting practice with this type of annealing, where there may be 20 to 30 tubes along the side of the furnace, is that the temperature at different ends of the furnace may be kept at different levels if two dissimilar products, each requiring a different annealing cycle, are being heat treated at the same time. Such control, which has worked out so very effectively in all Lee Wilson furnaces, is only possible with vertical tubes. It is a fact that it is possible to set a furnace and go away and leave it without further supervision, and have it produce an absolutely uniformly heated charge without changing burner conditions or changing control conditions.

Another interesting feature has been the gradual evolution of the all-fabricated tube from the original all-cast tube. Basic considerations have led to this change through the short history of the Lee Wilson radiant tube furnaces. In the vertical tube design, where careful consideration can be given to the heat

along the tube must automatically adjust itself to the changing conditions.

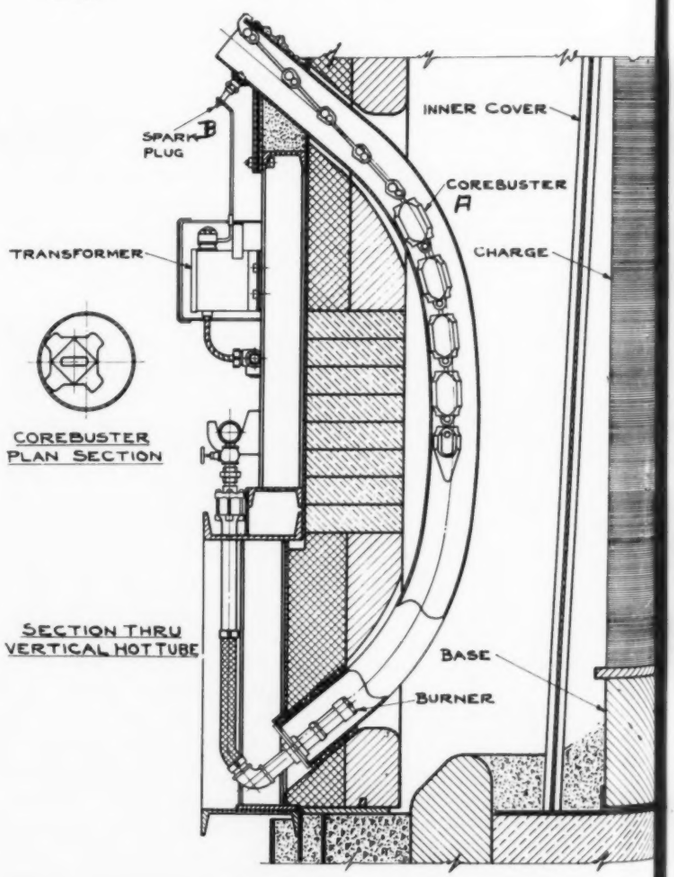
In Figure No. 7 an attempt is made to illustrate the system of control we are examining. The automatic vertical control shown on the chart is designed to automatically regulate the temperature distribution from the top to the bottom of the charge. As is shown, a thermocouple is located on the top edge of the charge. This thermocouple is connected to the control instrument.

Another thermocouple "B", or telltale couple, is located in the center bottom of the charge, or, in other words, at a point in the charge which is the most difficult to heat. In most furnaces, it is, of course, much easier to heat the top than the bottom, due to the natural convection currents within the furnace, as well as the greater exposed area of the top, which absorbs radiation.

With this in view, the vertical tubes are fired in such a manner that during the first of the cycle the heat distribution is such that the top and bottom are heated at about the same rate, the top coming only slightly ahead of the bottom. As the top corner of the charge approaches a point 50 degrees from the maximum temperature desired, thermocouple "E" causes the control instrument to gradually reduce the flame height in the tube by reducing the supply of fuel. As the thermocouple gradually approaches the maximum temperature desired, the flame height, or effective heating height of the tube, gradually diminishes, the temperature at the bottom of the tube remaining very nearly constant, while the heat given off at the top of the tube is reduced. In this manner it is possible to bring the bottom of the charge to temperature automatically.

This constant heat head is the unique characteristic of this control system and is a distinct advantage over the "on and off" control mentioned in connection with

FIGURE 8—This shows two of the most important auxiliary pieces—"A"—the core buster and "B"—the ignition plug.



liberation along the tube, the tube being designed to fit the charge form rather than to fit the combustion system, a tube having definite curve characteristics is essential. This is easily obtained in the sheet metal tube.

The sheet metal tube also offers another striking advantage in the wall thickness, made as it is of No. 11 gauge hot rolled alloy, usually of the 25% chrome, 12% Nickel variety. The parabolic design, which is bolted at the top and free to expand along the curve and out the bottom, relieves itself of strains due to repeated heating and cooling. The parabolic tube evolution from the original all-cast tube through partially fabricated tubes, was gradual, and undoubtedly the latest development has shown the best results of any we have been able to develop to date and the record for the all-fabricated tube is almost perfect.

Part of this improvement in results is unquestionably due to a better understanding of the correct amount of heat to be liberated per square inch of tube surface, which is again reflected in the amount of gas burned per tube. This information exactly parallels the early development stages passed through in applying resistors to electric furnaces, as described in an earlier paragraph.

Someone in a discussion of a paper before this Society has remarked that he has never seen a B.t.u. and that as soon as he has been able to see one of them flying around, he will certainly collar it and show it to his Annealing department employes. We should also like to report progress along this line. While we have not yet seen a B.t.u., we have definite evidence of its existence and its presence is often made known by the noise which is made when nature is trying to convert molecules of hydrocarbon gas to heat units, and for some reason or other it is not getting the correct amount of oxygen to which it feels it is entitled. When such a condition exists, it is often likely to squeal, and I cite this as audible evidence of its existence.

As these tubes have become better understood and more efficient operation has developed, certain auxiliary parts have been designed with definite objects in view. Referring to Figure No. 8 which follows, the two most important auxiliary pieces may be seen in "A", which shows the core buster, and "B", which shows the ignition plug. The function of the core buster is obvious. Boiler experience and other studies of heat transfer by convection gases through a tube wall have developed certain formulae that show the rate at which heat is transferred from a moving column of gas through metal walls. Among other factors, an important one is the velocity of the moving gas column and anything that tends to increase this velocity is a step in the direction of improving the efficiency of the gas used as a heat transfer medium. These core busters perform this office, and, in addition, they, being in the center of the hot column of gases, become heated to some temperature slightly in excess of the outside surface wall of the tube and serve as additional radiating surface.

Again, the use of the spark plug igniter, located at the exhaust end "B" as shown, adds to the ease with which these furnaces can be lighted up after a shut-down period and makes the ignition of the gas cover as simple as that of an electric cover.

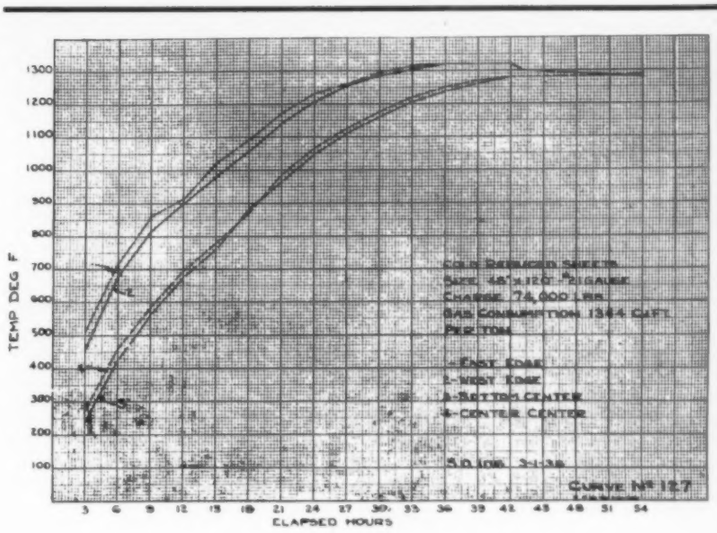


FIGURE 9—This curve shows a charge of 37 tons of sheets 48 inches X 120 inches of cold reduced material suitable for auto body stock.

It seems, in a general paper of this nature, it would be of interest to cite the number of applications of the different makes of portable covers and throw the discussion open to the relative merits of the various units which are in operation by the operators of these units.

The curves shown here are offered as an indication of the degree of temperature control and uniformity attained in this type of apparatus.

Figure No. 9 shows a charge of 37 tons of sheets 48 in. x 120 in. of cold reduced material suitable for auto body, etc. In this curve thermocouple "1" or "2", is located on the edge of the stack near the top, the first part of the stack to come up to the desired annealing temperature. This couple holds the temperature of the charge at the desired annealing point by actuating the throttling control gas valve through the pyrometer mechanism, while the temperature of the charge at the last part to come to temperature, as recorded by thermocouples "3" and "4" come up to the approximate temperature of thermocouples "1" and "2".

Figure No. 10 shows the annealing history of a charge of cold reduced tin plate coils. It will be noticed that this charge consists of a total of 16 coils, 8 forming one layer, with the second 8 placed directly on top of them.

CYLINDRICAL FURNACE

In closing it is always well to take a look at the present status of a piece of industrial equipment which has an expanding application and the most recent interest of the consumer has been centered upon smaller units than were formerly used for small production programs, but for higher quality products as regards surface and annealing cycles. These pictures show this new equipment as it has been designed to meet this demand and you can see by looking at them that the general features of the vertical radiant tube portable

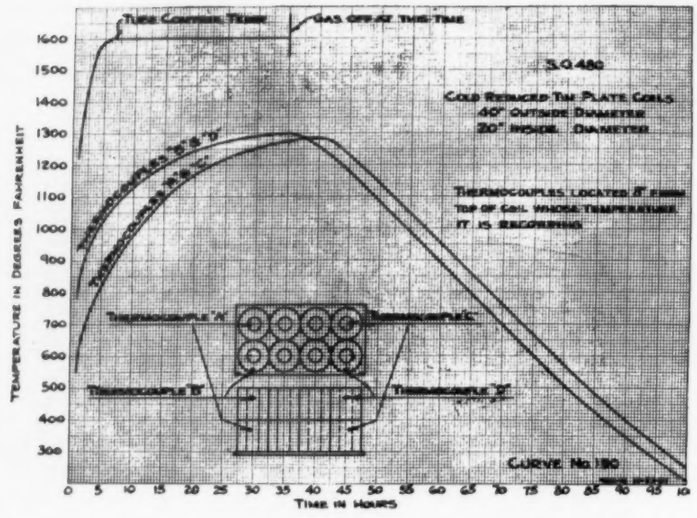


FIGURE 10—Annealing history of a charge of sixteen coils of cold reduced tin plate. These are arranged in two layers of eight each.

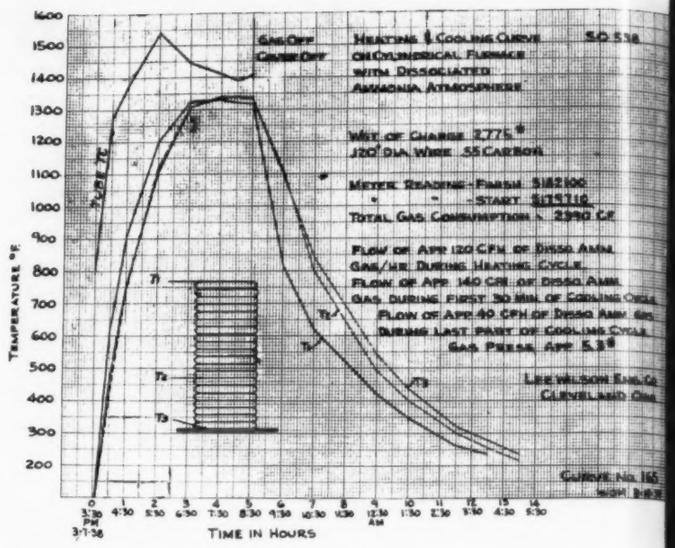

GAS OFF
CURRENT OFF
HEATING & COOLING CURVE ON CYLINDRICAL FURNACE WITH DISSOCIATED AMMONIA ATMOSPHERE
S.O. 538
WT. OF CHARGE 2775 #
120 DIA. WIRE .55 CARBON
METER READING - FINISH 5182100
" " - START 5175710
TOTAL GAS CONSUMPTION 6390 CF
FLOW OF APP 120 CFH OF DISSO AMMA GAS/HR DURING HEATING CYCLE.
FLOW OF APP 140 CFH OF DISSO AMM. GAS DURING FIRST 30 MIN. OF COOLING CYCLE
FLOW OF APP 40 CFH OF DISSO AMM GAS DURING LAST PART OF COOLING CYCLE
GAS PRESS. APP 5.3 #
LEE WILSON ENG. CO CLEVELAND OHIO
CURVE No. 165
TEMPERATURE °F
TIME IN HOURS

FIGURE 12—Heating and cooling curve on cylindrical furnace with dissociated ammonia atmosphere.

cover have been retained, but that the shape of the furnace has become cylindrical.

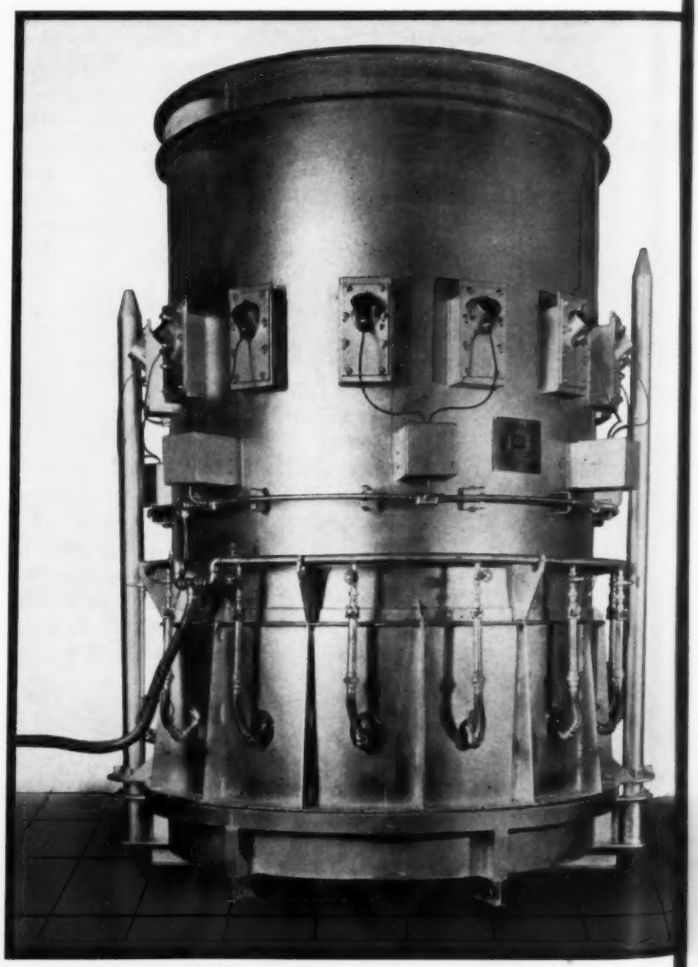
Here we have the tubes equally spaced around the inside circumference of the portable cover, the inner hood sitting over the base, on which the charge is stacked and in this case, because of the atmospheric requirements, involving more expensive gas, provision has been made for a liquid seal. The base is equipped with a fan and a very compact unit has been developed. While these units are designed for high quality, low tonnage, short cycle charges, it is interesting to note their heating and cooling characteristics and the influence of a fan upon the heating cycle.

Figure No. 11 shows the view of the recently developed cylindrical type cover for high pressure gas. Attention is called to the inspirator type burner and the electric ignition at the exhaust end of each parabolic tube. These tubes are equipped with core busters and form a very efficient compact apparatus.

Two time-temperature cycles are given to show the rate at which small charges of steel in one case, and in the other case, of wire rod may be heated and cooled in this type of apparatus.

Figure No. 12—the thermocouples in this charge were located—one control thermocouple, called the tube thermocouple, functioning by preventing the temperature on the tubes exceeding some 1550 deg. F., while the thermocouple No. 1, located near the top, being buried under several wraps of the rod, attained a temperature of 1330 deg. F., the desired annealing temperature. When this thermocouple registered the control automatically passed from the tube thermocouple to thermocouple No. 1 and the other thermocouples "2" and "3", located, as shown, registered temperatures in the rod as time progressed.

FIGURE 11—The recently developed cylindrical type cover for high pressure gas. This features the inspirator type burner.



Typical installation of radiant tube type annealing covers. This is a partial view of a unit consisting of seventy-six covers.

We have made a study through the years with the idea of trying to establish in our own minds the relative need of a fan and whether a shorter heating cycle would be obtained when the hollow center cylinders were being heated, and, if so, whether the shortened heating cycle would be sufficient to justify the additional expense for the fan in the base to circulate these gases. This has been a much discussed question for many years among furnace designers and so many inconsistent results have been obtained that we wished to determine for ourselves, if possible, the exact value of a furnace equipped with fans.

We arranged to make a series of tests approximately 1½ years ago. Four fans were installed in a rectangular cover base. The test coils were drilled half way through the annular ring so thermocouples could be placed in them to measure inside temperatures. One inner cover was set down over the whole charge. These test data, when compared with regular annealing practice at the plant, did not show enough change in time or temperature distribution to make application of fans desirable.

Recently there was occasion to design and build a cylindrical cover for annealing coils. In this design, care was taken to arrange the parts so that the fan could maintain high gas velocities through the system. The cover was set up for extensive tests in the laboratory.

The most interesting fact that has been developed so far in regard to the use of fans has been that the velocity of the gases must be above a certain speed. This velocity is critical and if not attained, the fan does not appreciably shorten the heating cycle, or the cooling cycle.

DISCUSSION

BRAY AND KEW

(*Continued from page 35*)

the time a motor or generator is out on the floor ready for the replacement the required part has already arrived. This policy holds true for both electrical and mechanical parts.

A question that only time will properly answer is that pertaining to the life-expectancy of the railway Diesel. So many factors enter into this that it would be impossible to formulate a definite answer. However, I know of gasoline-electric motor cars that have been in active service for twenty-six years and I must say that from a design standpoint the engines were far inferior to the modern Diesel engine.

There are probably a great many questions in your minds that have gone unanswered, but if I have cleared up a few of the more outstanding ones here tonight I feel that a great deal will have been accomplished. So in closing I want to thank you all for your kind indulgence in the subject on hand.

L. J. BRAY: I would like to answer a question asked by Mr. Knabe which Mr. Kew and I overlooked, and that concerns the reconditioning of pistons and liners. The present practice is to use pistons and liners until either or both become worn to the extent that it is not possible to secure proper compression. These are replaced by either standard sets or over sized parts depending on operating conditions. The removed liners are returned to the manufacturer on a unit exchange basis. The reconditioning of pistons and liners by either a plating process or welding has not been a part of the program to date. It is being successfully done in several places but is a phase of maintenance which will no doubt develop as the units continue in service and as the technique of reclaiming these parts proves that it will warrant setting up equipment for the work. The individual user of Diesel units must balance this practice against the unit exchange plan. However, these developments actually haven't been considered, because we have not had to replace those particular parts up to the present time, nor are we definitely aware of when a change will be necessary.

C. M. THOMPSON, JR.: Such a very complete and thorough system of inspection of maintenance as Mr. Bray has outlined tonight can well be applied to other steel mill equipment. I am sure we will all leave here tonight with a lot of food for thought along that line.

Before adjourning I would like to suggest a rising vote of thanks to Mr. Bray and Mr. Kew for their excellent presentation.

F. O. SCHNURE

POWER REQUIREMENTS of a 56" HOT STRIP MILL

▲ TWO of the chief engineering and economic problems arising in connection with the installation of a new hot strip mill are the layout of the power system and the selection of the drives. After the general design of the mill has been determined, past experience on previous installations furnishes a reliable guide for determining the ratings of the electric drives. This phase of the engineering has now become largely a matter of working out the details of the electric drives to suit the peculiarities of the mill design. Because of the large amount of power required, very few steel plants can assume the additional load of a new hot strip mill without major additions to the power system. The determination of the best means for supplying the additional power is largely an economic problem. Since each steel plant power system presents problems peculiar to that system, little general information is available to assist in the solution of the economic and engineering problems involved.

It is the purpose of this paper to show how the solution of the problems mentioned, was arrived at, for the recent additions to the Maryland Plant of the Bethlehem Steel Company; and more particularly to describe the electrical features of the main drives on the new 56" hot strip mill and a test of these drives made for the purpose of checking the power requirements of the mill.

POWER SYSTEM

In 1936, when the new 56" hot strip mill, No. 2, 42" tandem cold strip mill and 10" rod mill were proposed, power for the Maryland Plant was being obtained from the following sources.

6—Gas engine generating units	18,000 kw.
1—Turbo generator	10,000 kw.
1—Turbo generator	20,000 kw.
5—7500 kva. transformers—Purchased power	37,500 kw.
Total installed capacity	85,500 kw.

The entire system operated at 25 cycles. At high tonnages, momentary peaks up to 85,000 kw. were being carried regularly; with no spare capacity available. Consequently, it was obvious that the requirements of the new mills would necessitate the consideration of additional capacity. The power requirements of the new mills were estimated as follows:

Mill	Hourly Demand	Peak Demand
56" Hot strip	15,000 kw-hr.	25,000 kw.
No. 2 Cold strip	4,500 kw-hr.	5,000 kw.
No. 2—10" rod	5,000 kw-hr.	6,000 kw.

It was concluded to purchase this power requirement from the local power utility at Baltimore, who were in a position to furnish large quantities of power from the hydro developments on the Susquehanna River, and to obtain it over a new transmission line from the utilities system to Sparrow's Point.

The utility proposed to furnish 60 cycle service with a 20,000 kw. frequency changer operating between their system and the Maryland Plant's 25 cycle system. The frequency changer was to serve two purposes. First, to provide spare capacity for the existing Maryland Plant 25 cycle power system and second; to permit the utility to furnish part of the 25 cycle load from their more efficient 60 cycle system. It was also favorable to the Maryland Plant to establish 60 cycle service for the new mills because of the many inherent advantages such as lower cost, greater availability of equipment and larger range of synchronous speeds available for motor drives. Also, the general trend in both the utility and steel industries is to extend the use of 60 cycle power.

This 60 cycle service is supplied through two 33 kv. 25,000 kw. circuits from the Riverside Station of the utility which station is backed by all the utility's steam stations, as well as the Pennsylvania Water & Power

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Presented before the A. I. & S. E. Annual Spring Conference, Baltimore, Md., April 28 - 29, 1938.

R. H. WRIGHT

Company's hydro stations at Safe Harbor and Holtwood and, through interconnection, by the Washington, D. C. power system. The two 33 kv. circuits terminate at the Maryland Plant in two 33/6.6 kv. substations. One substation has four 10,000 kva., 3 phase transformers and is located about 2000 feet from both the hot strip mill motor room and the cold strip mill or frequency changer substation. The other transformer substation is located at the rod mills and has a single 10,000 kva., 3 phase transformer.

A 20,000 kw. frequency changer is installed in the cold strip mill substation where space and crane service available. The cold strip mill substation is approximately two miles from the Maryland Plant 25 cycle power house. This location is strategic from a power distribution standpoint, since the 25 cycle load in the adjacent tin and sheet mills is about 20,000 kw.

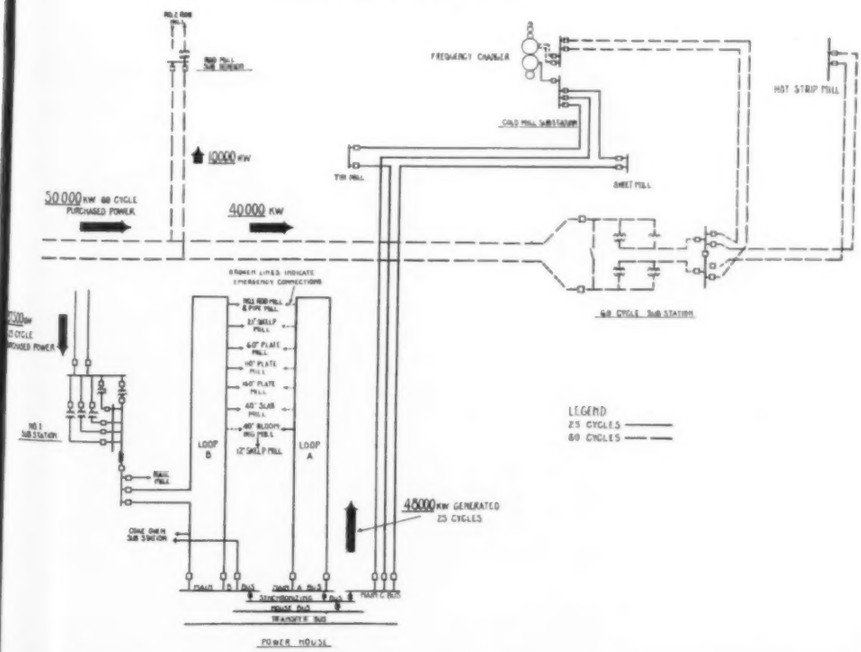
Figure 1 shows schematically the arrangement of the transmission system for both 25 cycle and 60 cycle power.

An interesting feature of the frequency changer installation was the addition of a 3500 kw., 600 volt, d-c generator on the end of the set. This generator supplies power to No. 2 42" tandem cold mill. This combination represents an economy in space, foundations, auto-transformers and switching equipment and allows the frequency changer to be started by Ward-Leonard control from the adjacent 3500 kw., motor generator on No. 1 tandem cold mill, using the 3500 kw. generator on the frequency changer set as a motor. Thus a normally tedious starting job is simplified greatly. Both the 25 cycle and 60 cycle machines are provided with amortisseur windings so that in an emergency the set can be brought up to speed by connecting the 25 cycle end to a generator in the power house and bringing the set and the generator up together.

The bulk of the energy supplied through the 60 cycle power system is used by the 56" hot strip mill. It is the power characteristics of this mill with which this paper is particularly concerned. Figure 2 is a general view of the motor room.

Since the mill has operated only a few months at low capacity, overall power consumption figures are not

FIGURE 1—Arrangement of the transmission system for both 25 cycle and 60 cycle.



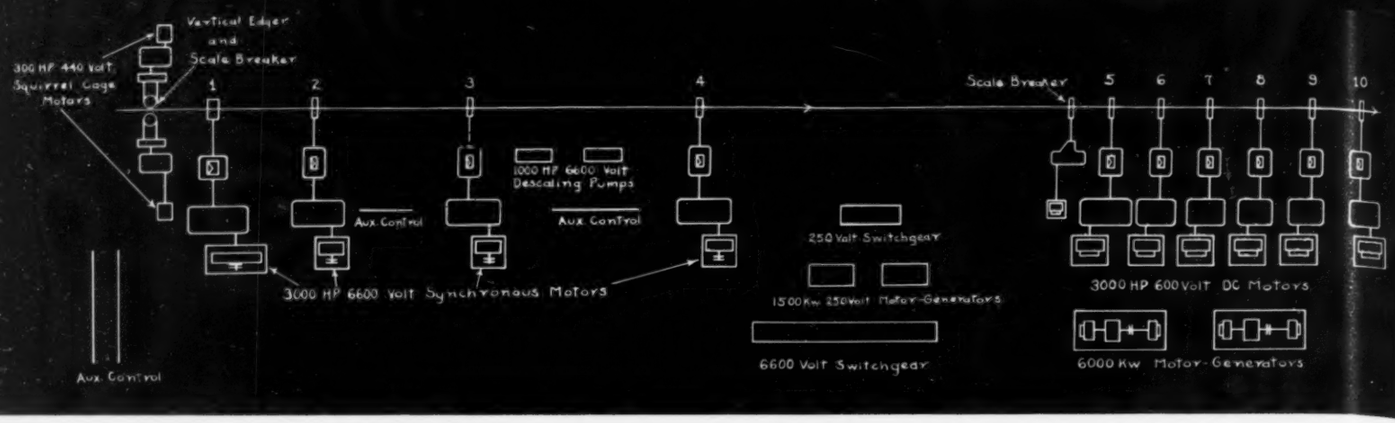


FIGURE 3—Arrangement of the roughing and finishing stands of a 56″ hot strip mill.

representative of practice under normal schedule. However, the following figures obtained from a normal day's operation, indicate the power consumption to be expected when operating at normal tonnage.

Maximum instantaneous demand	28,000 kw.
Power Factor with mill loaded	97 per cent Lag to 97 per cent Lead
Kw-hr. per gross ton charged:—	
Main drives including fans and exciters	48.5
Hot mill auxiliaries	12.6
Finishing mill auxiliaries	8.8
Water-descaling and steam systems	12.1
Total	82.0

To date the new mills have raised the maximum instantaneous system power peak from 85,000 kw. to 103,000 kw. Plant operation has been considerably under normal during this period so that the peaks on full operation may be over 120,000 kw.

The mill consists of a vertical edger which serves as a roughing scale breaker, four 56″ roughing stands, a finishing scale breaker and six 56″ finishing stands. The arrangement of the stands is shown in Figure 3.

ROUGHING TRAIN DRIVES

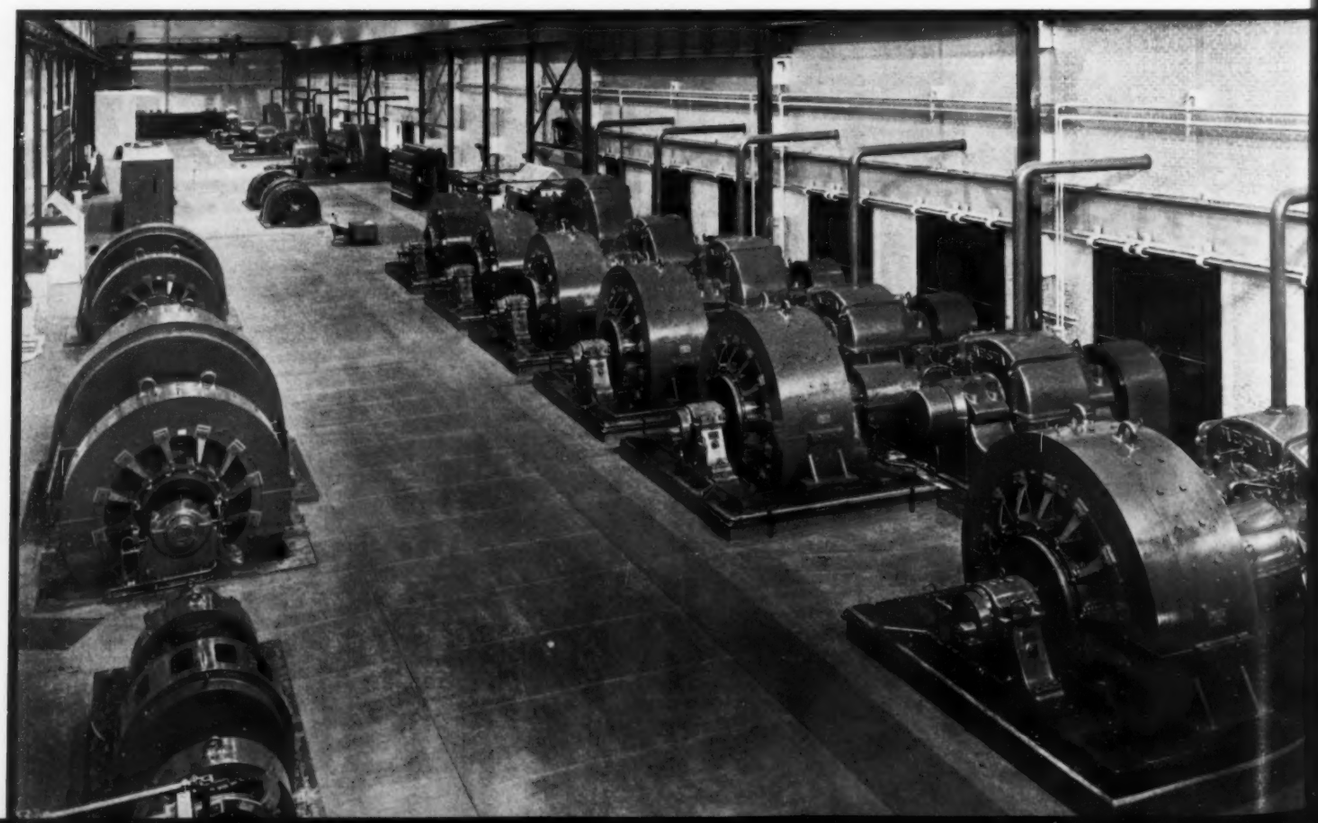
Each roll of the vertical edger is driven by an individual 300 hp., 500 rpm., 440 volt squirrel cage motor. One motor is located in the motor room and one in a pit under the mill floor. This arrangement simplifies the mechanical design of the edger and the operation is quite satisfactory. Load division between motors is never perfect, but the motors are of ample capacity and the method of drive is satisfactory from the standpoint of mill operation.

Three methods of driving the roughing stands were available; induction motors with flywheels, induction motors with no flywheels, and synchronous motors.

No. 1 stand is geared for a roll speed of 181 fpm. Since this stand was not to be used for spreading and considerable tonnage was to be rolled from long slabs; there was no particular advantage, from the electrical standpoint, in using a flywheel for this stand.

In some previous installations the gearing has been arranged so that stands 2, 3, and 4 all had the same delivery speed of around 400 fpm. This arrangement makes the gearing and motors duplicate for all three

FIGURE 2—Motor room of the 56″ hot strip mill, Bethlehem Steel Company, Sparrows Point, Md.



stands, but gives heavy loads on No. 2 stand. In such cases it has been customary to use an induction motor drive with a flywheel for No. 2 stand; and stands No. 3 and 4 have frequently been driven in the same way. For the Maryland Plant mill it was decided to reduce the loads of No. 2 stand by gearing this stand for a lower speed. No. 2 stand accordingly was geared for 285 fpm. For this speed it was decided that a flywheel would be of little or no value in equalizing the loads.

Stands 3 and 4 are geared for a speed of 430 feet per minute. Due to the duration of the passes in these stands, flywheels were not considered essential.

For the above operating conditions it was decided that all four roughing stands could be driven either by induction motors with no flywheels or by synchronous motors. Synchronous motors were chosen because of greater simplicity of control and lower total cost. Load calculations indicated that peaks in excess of 6000 hp. could be expected on any of the four roughing stands. Accordingly four 3000 hp., 100 per cent power factor synchronous motors with 300 per cent pull-out torque were selected for the roughing stand drives.

ROUGHING TRAIN LOADS

Figure 4 shows the range of loads on the roughing train when the mill was rolling product ranging from .047 x 38⅜ to .106 x 46¼. All sections were rolled from low carbon slabs 4½" thick. Rolling temperatures were in accordance with average practice; the recorder indicating temperatures of 1850 to 1900° F leaving No. 4 stand.

It will be noted that for the load conditions shown in Figure No. 4, the loads vary from slightly above 3000 HP. in Stand No. 1 to as much as 5000 to 8000 HP. in Stands No. 3 and No. 4. None of the loads shown exceed 6000 HP. or two-thirds of the peak capacity of the motors which is 9000 HP. However, in applying synchronous motors to roughing train drives, it must be taken into account that there is no flywheel effect to absorb or soften the peaks. Also, it must be taken into consideration that, in addition to the steady peak loads, oscillating loads are imposed on the motors by slippage of metal in the rolls. It is well known that when load is applied to a synchronous motor, the rotor moves back in phase position relative to the rotating field of the stator and when the load is released the rotor moves forward to the no load position. If the load is applied and released suddenly, the rotor oscillates while the shift in phase position is taking place, both when load is applied and when load is released. This is a characteristic common to all synchronous motors.

It will be noted that more margin in peak capacity has been provided in the drives for stands No. 1 and No. 2 because greater slippage was expected in these stands. The graphic chart and oscillogram shown in Figure No. 5 illustrate more in detail what goes on when load is applied to a synchronous motor and when load is released. Referring to the graphic chart at the bottom of the figure; peaks B and C at the right show normal load conditions. Peak A at the left shows the variation in input due to slippage of steel in the rolls. The oscillogram at the top of the figure shows more in detail, on a longer time scale, the input to one of the synchronous motors on the roughing train under normal

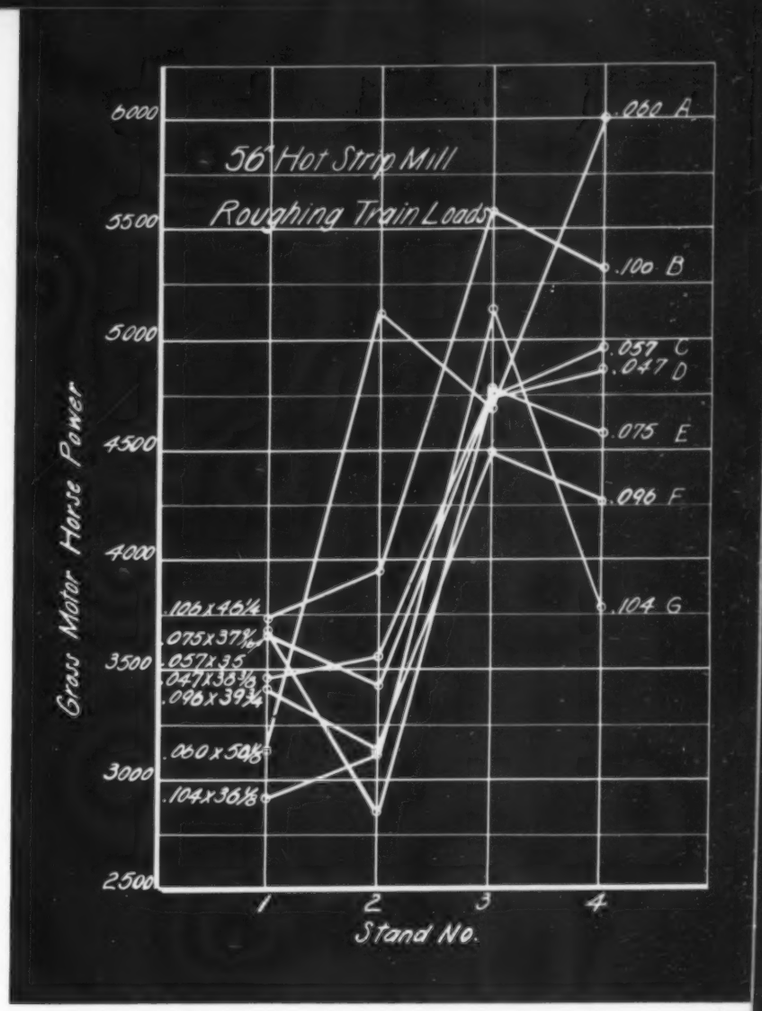
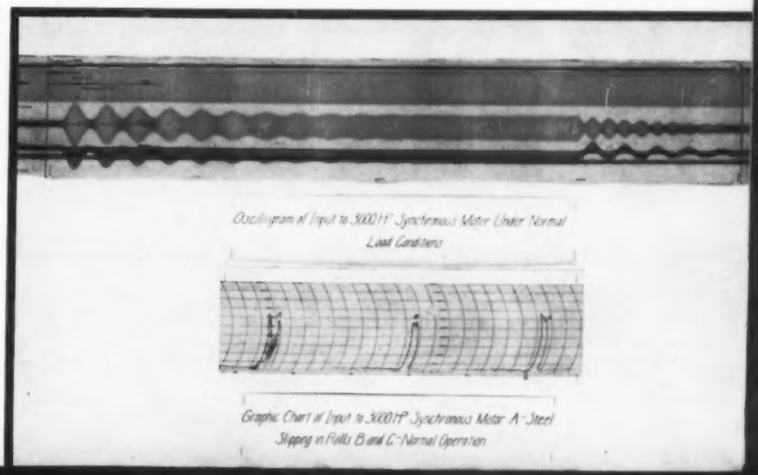


FIGURE 4—The range of loads on the roughing train when product ranged from .047 x 38⅜ to .106 x 46¼.

conditions. The part of this oscillogram of particular interest is the current curve which is the middle curve. This curve shows several oscillations after the metal enters the rolls. Following this the current input is steady up to the end of the pass. When the steel leaves the rolls there are again several minor oscillations. The period of the oscillations is determined by the design characteristics of the motor. The oscillogram shows a period of 23 cycles for that particular motor.

The oscillations of a synchronous motor do not affect

FIGURE 5—Oscillogram illustrating the transient conditions set up by load changes in one roughing stand motor.


Oscillogram of Input to 3000 HP Synchronous Motor Under Normal Load Conditions
Graphic Chart of Input to 3000 HP Synchronous Motor A-Steel Slipping in Rolls B and C-Normal Operation

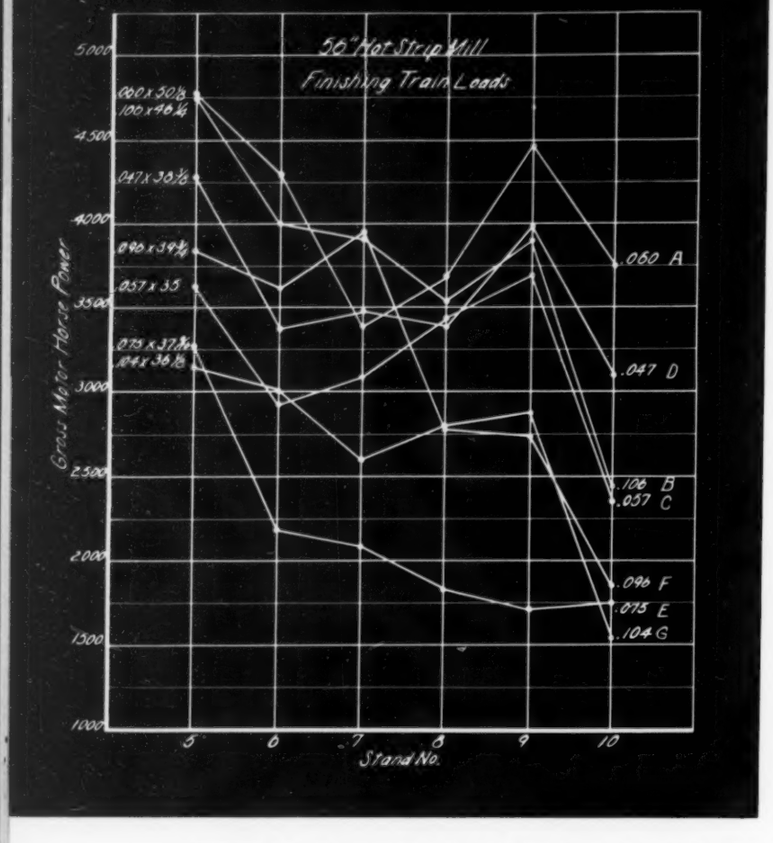


FIGURE 6—Range of typical rolling loads on stands Nos. 5 to 10 for products ranging from .047 x 38⅜ to .106 x 46¼.

the operation of the mill or the stability of the power systems. This is shown by the curves of Figure No. 9. It will be noted that the roughing train peaks are not a large factor in determining the total peak load of the mill.

FINISHING TRAIN LOADS

The finishing train drives consist of the following: 600 volt, d-c motors; 1—500 hp., 150/600 rpm., for the scale breaker; 5—3000 hp., 200/400 rpm., for stands 5 to 9 inclusive and 1—3000 hp., 175/350 rpm., for stand 10. Power is supplied through two 6000 kw. synchronous motor-generators. The finishing train is controlled by the conventional arrangement of high capacity circuit breakers, exciters, rheostats and control desk.

No. 2 scale breaker stand is operated with practically no pressure on the rolls so that the load is very light. Figure 6 shows the range of typical rolling loads on stands 5 to 10 for products ranging from .047 x 38⅜ to .106 x 46¼. Figure 7 shows the range of motor speed settings for the same schedules and Figure 8 gives the roll surface speeds of the various stands. It will be noted that all motors have ample margin of speed range and that none of the motors are subjected to excessive overloads. The mill was comparatively new when the tests were made and the working rolls of the finishing stands all had practically the same

FIGURE 7—Range of motor speed settings for products ranging from .047 x 38⅜ to .106 x 46¼.

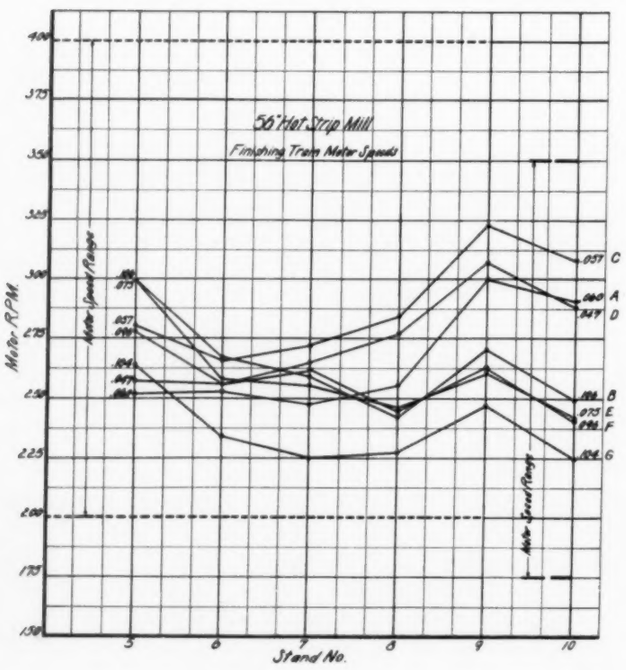
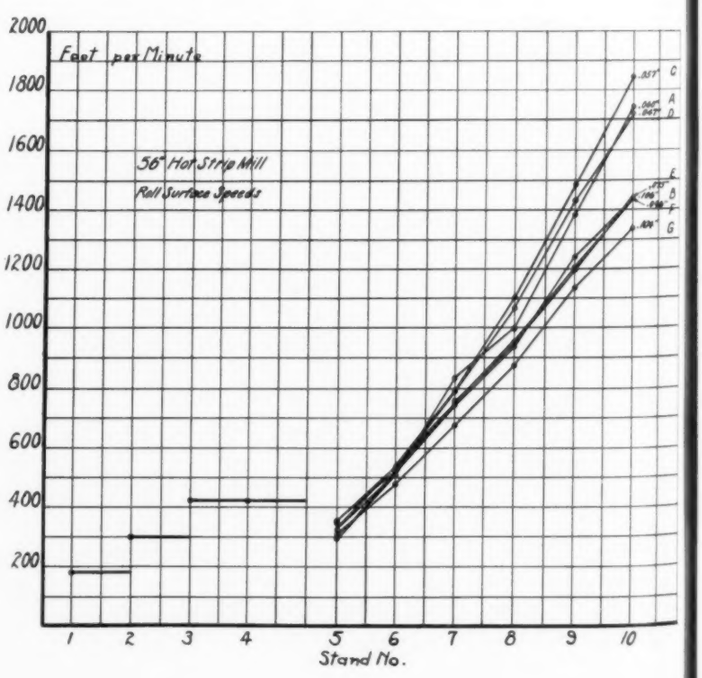


FIGURE 8—Roll surface speeds for products ranging from .047 x 38⅜ to .106 x 46¼.



diameter. As the mill becomes older, necessitating operation with new rolls and worn rolls in adjacent stands, more of the available speed range will be needed. The curves of Figure 7 indicate that ample margin is available to compensate for variations in roll diameter. Also there is a tendency for the roller to use higher delivery speeds which will shift the running speeds more nearly to the middle of the range.

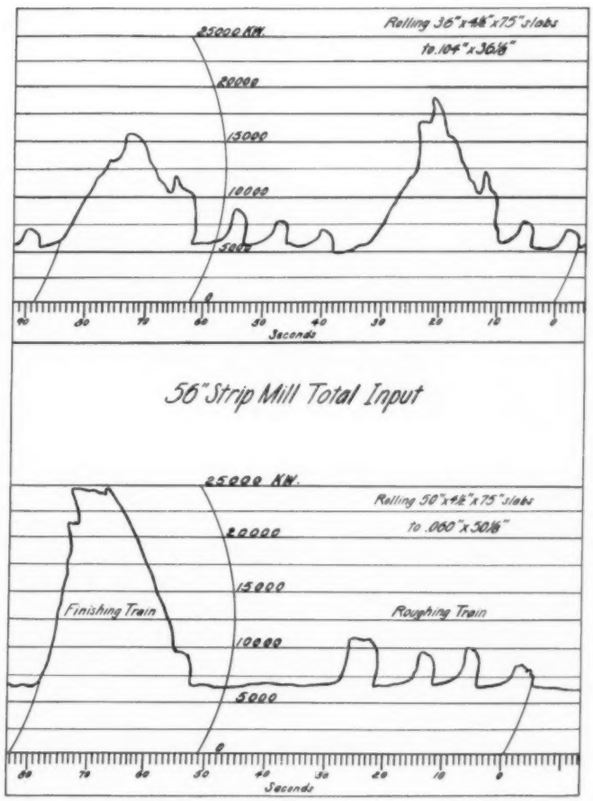
TOTAL MILL LOAD

All the power for the entire mill is supplied through two 6600 volt lines. A special graphic wattmeter records the combined load on both cables. In Figure 9 are reproduced two high speed graphic charts of the total mill load. One chart shows the load when rolling 50″ x 4½″ x 75″ slabs to .060″ x 50⅛″ and the other when rolling 36″ x 4½″ x 72″ slabs to .104″ x 36⅛″.

Figure 10 shows slow speed charts of the load on the roughing mill motors and of the total input to the mill during a typical 16-hour run. Figure 11 is a photograph of a set of slow speed ammeter charts made at the same time on the finishing train.

During the 16-hour period shown the mill output was 1593 finished gross tons of .090 x 28¾ and 497 finished gross tons of .075 x 29¼″.

FIGURE 9—Two high speed graphic charts of the total mill load.



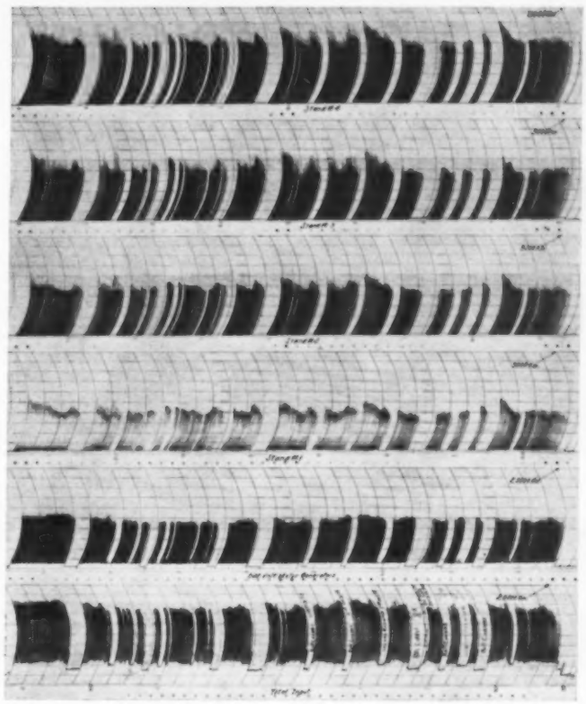
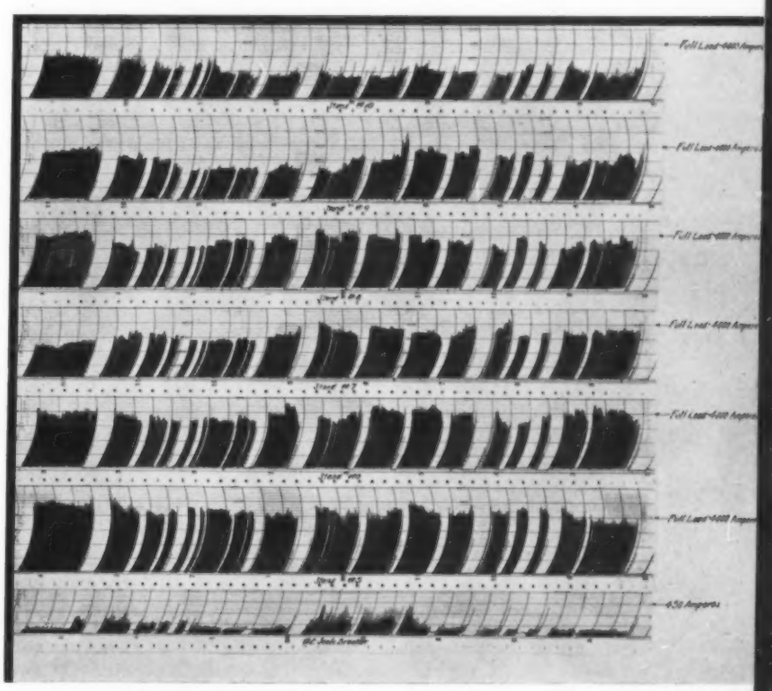


FIGURE 10—Slow speed charts of the load on the roughing mill motors and the total input to the mill during a 16 hour run.

For studying the mill performance in detail, the following instruments are available:

1—Graphic totalizing wattmeter for the two 6600

FIGURE 11—A set of slow speed ammeter charts made at the same time on the finishing train.



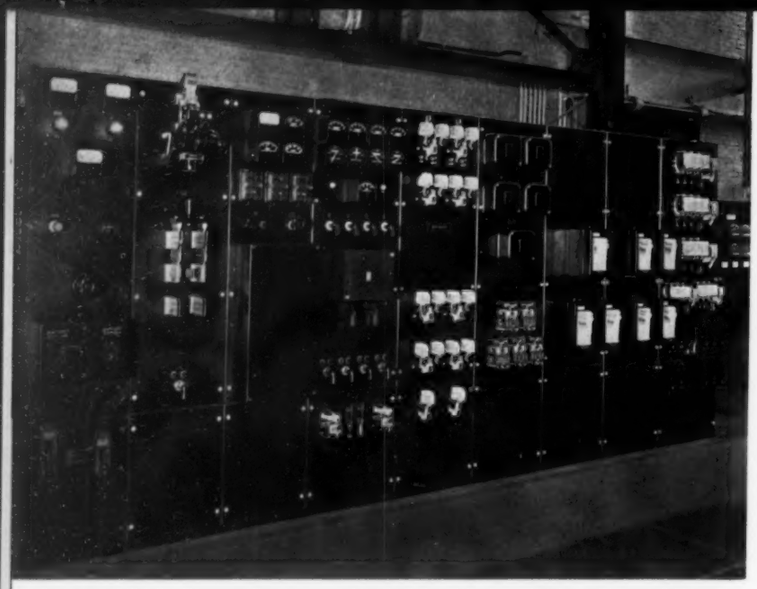


FIGURE 12—Located adjacent to the finishing train control board and consisting of a d-c bus voltmeter, an ammeter and a speed indicator is this set-up used for speed readings.

volt incoming lines, especially built for this installation.

1—Totalizing watthour meter.

4—Graphic wattmeters for the 3000 hp. roughing mill motors.

4—Watthour meters for the 3000 hp. roughing mill motors.

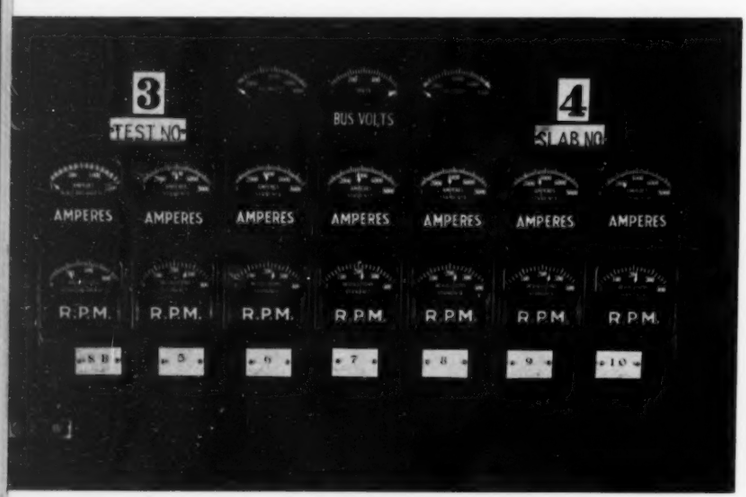
1—Graphic totalizing wattmeter to record the combined input to the two 6000 kw. motor generators.

1—Watthour meter for the two 6000 kw. motor generators.

7—Graphic d-c ammeters for the 600 volt, d-c finishing mill motors.

All graphic instruments are equipped with chronograph pens which are connected to a common circuit. During the tests described in this paper an additional set of indicating instruments was unstalled for the finishing mill motors. This set of instruments consisted of a d-c bus voltmeter, and an ammeter and a speed indicator for each motor in the finishing train. As shown in Figure 12, these instruments were mounted on a panel adjacent to the finishing train control board. This set of instruments was used principally for speed readings, since no graphic speed indicators were installed with the equipment. It was thus unnecessary to have men in the pulpit to make speed readings during test runs. This eliminated danger of interference with the pulpit operators and made it easier to co-ordinate the work of the men making the test. Since the instruments were close to the motors it was very easy to make speed calibrations. Two methods of recording the speeds were used. One method was to have two observers, each recording the readings of three meters for each slab tested. The other method was to photograph the entire board with a high speed camera. Figure 13 is a reproduction of a photograph made for this purpose.

FIGURE 13—One method of recording the speed was photographing the entire board with a high speed camera. Below is a reproduction of a photograph made for this purpose.



TEST PROCEDURE

Fundamental power data which can be plotted in curves showing net energy consumption per ton against elongation or net energy consumption per cubic inch displaced against percent of original area can be obtained by two general methods. One method is to record the energy consumed by the various drives in a certain period of time, the total tonnage rolled in the same time and the area of the section leaving each point at which energy readings are taken. By making proper allowances for no-load running losses and electrical losses at rolling loads, the net energy consumed per unit of work done at various stages of the total reduction can be computed. This method is applicable to rod or merchant mill tests where data can be taken over long periods at fixed conditions.

Strip mills usually do not operate for long periods on one schedule so usually it is more convenient to use a second method of obtaining data for energy-elongation curves. In this method the net energy required in each stand for one or more slabs is calculated from accurately timed graphic charts. The total net energy expended up to any point in the rolling schedule can then be calculated and curves of net energy per unit of work done plotted against elongation or percent of original area.

In Figure 14 are plotted curves obtained in this manner from tests on the Maryland Plant 56″ mill. Curve A is an average of tests on the following schedules.

.057 x 35
.061 x 50
.075 x 37½

All sections were rolled from 4½″ thick low carbon slabs. When separate curves are plotted for each test, the curves are found to be practically coincidental. Curve B is an average of tests on .106 strip rolled from 4½″ slabs. On Figure 15 the same curves are plotted in logarithmic form. The general procedure followed in using such curves for load calculations is quite generally known and need not be outlined here.

Each set of test data used in plotting the energy-elongation curves represents an average of five slabs rolled under average conditions. In determining the

values used in plotting the curves, mill no load friction and electrical losses have been eliminated. The curves, therefore, indicate the performance of the mill itself. The same curves could be made for a mill with steam engine drives if proper allowances were made for losses in the drives.

These curves indicate that the modern high speed strip mill is more efficient than older mills operating at slower speeds. To illustrate, there is a curve in the June 1932 issue of the Iron & Steel Engineer giving the power characteristics of a roller bearing strip mill having a delivery speed of 1200 feet per minute. At 50 elongations this curve shows net energy consumption to be 65 horsepower hours per net ton for 3″ slabs. Another curve prepared at about the same time shows an energy consumption of 58 horsepower hours per net ton at 50 elongations for 4″ slabs.

It will be noted that the upper curve of Figure No. 14 and No. 15 indicates a net energy consumption of 43 horsepower hours per net ton finished at 50 elongations.

The procedure followed in making detailed tests on the mill was as follows: One observer was located at the furnace, one in the finishing mill pulpit, and one at the coiler or piler. Two men ran the graphic meters and marked the charts, a photographer or two observers recorded the finishing mill speeds and two men coordinated the work of all the testers. With all testers at their respective stations a lamp was flashed in the motor room when the observer at the furnace signalled that conditions were satisfactory for starting the test. Two slabs were allowed to pass through to allow time for starting the graphic meters and timing pens. For the next five slabs all charts were marked to indicate the slab number. The observer at the furnace recorded the weight of each of the five test slabs and the observer at the coiler recorded the exact width, thickness and weight of each coil. If the material was being sheared, this observer recorded the width and thickness at the piler. The mill screwdown settings during each test were also recorded. When finishing train speeds were recorded with a camera, two tests of terra cotta number plates were used on the special instrument panel to indicate the test number and slab number so that the negatives could be identified readily.

DYNAMIC BRAKING FOR FINISHING STANDS

The question frequently arises as to whether it is advisable to provide dynamic braking for the finishing mill motors and practice has not been uniform in this respect. Where dynamic braking equipment has been installed it is used to prevent damage to the mill when cobbles occur. One of the common causes of cobbles is failure of the strip to enter one set of rolls. If the stand which the steel does not enter is allowed to run there is always danger that the end of the strip eventually may be forced into the rolls. Then several thicknesses are almost certain to be drawn into the rolls and the rolls broken. If this stand is stopped or slowed down materially as soon as the cobble starts, the chances for serious damage are reduced greatly. Also, if the second stand preceding the cobble is stopped the cobble can

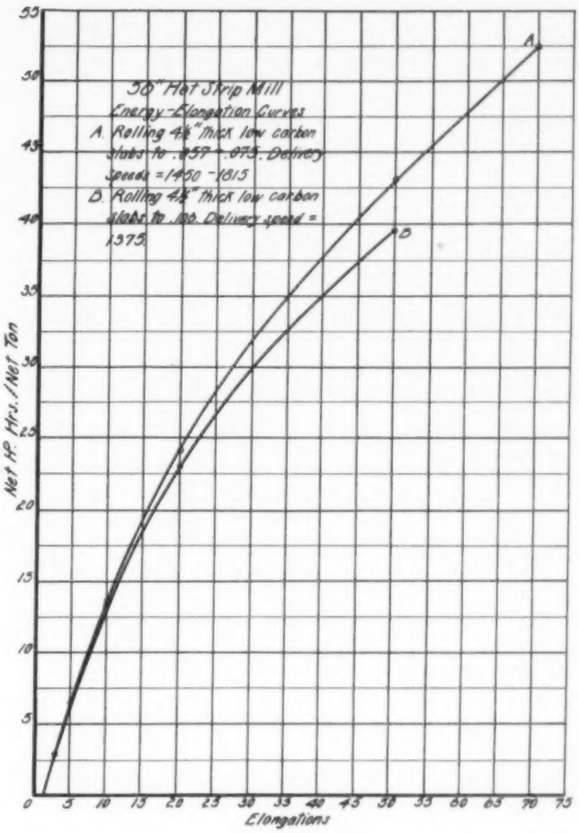
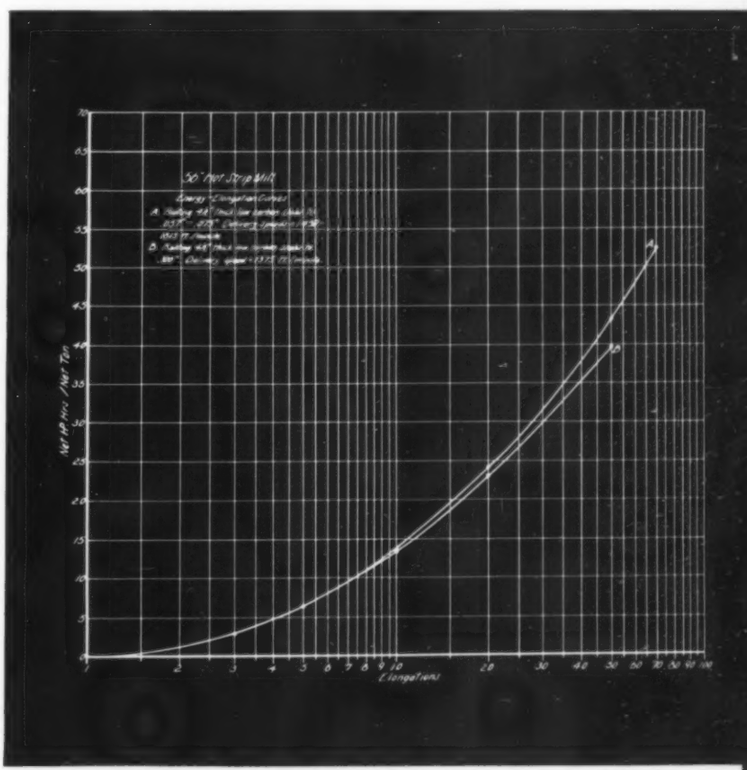

56" Hot Strip Mill
Energy-Elongation Curves
A. Rolling 4½" thick low carbon slabs to .057"-.075". Delivery speeds = 1450 - 1615
B. Rolling 4½" thick low carbon slabs to .100. Delivery speed = 1375
A
B
Net HP Hrs. / Net Ton
Elongations

FIGURE 14—Energy versus elongation curves plotted from tests made on the 56″ hot mill of Bethlehem's Maryland plant. All sections rolled were from 4½″ thick low carbon slabs.

FIGURE 15—The same curves used in Figure 14 are shown here plotted in logarithmic form.



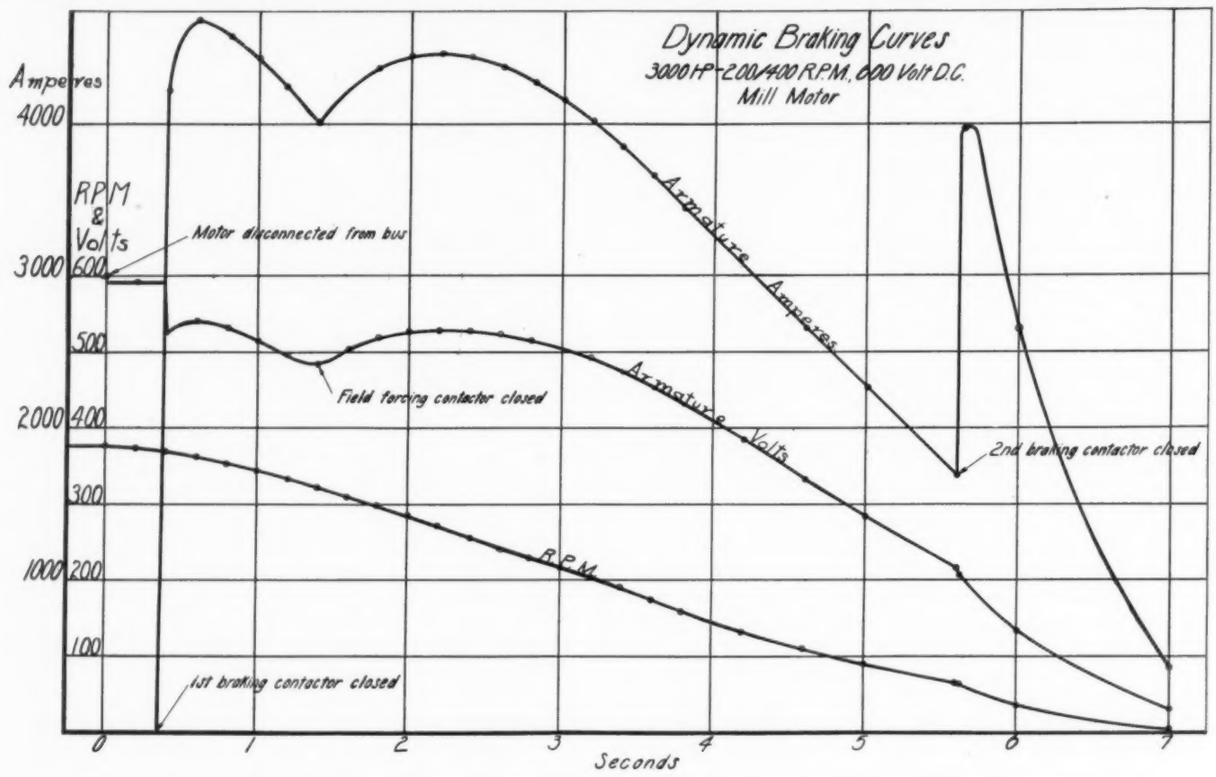


FIGURE 16—Reproduction of an oscillogram taken when dynamic braking was applied to No. 5 stand and shows current, voltage and speed when dynamic braking is applied at 377 rpm. with no steel in the rolls.

be divided into two parts, thus making it easier to clear the mill.

Dynamic braking has been provided for the finishing train drives of the 56″ mill at the Maryland Plant. Figure 16 is a reproduction of an oscillogram taken when dynamic braking was applied to No. 5 stand. This stand is driven by a 3000 hp., 200/400 rpm. motor. The oscillogram shows the current, voltage and speed when dynamic braking is applied at 377 rpm. with no steel in the rolls. The control arrangement used provides three braking steps.

A fraction of a second after the motor is disconnected from the bus the main braking contactor closes. The braking resistance is designed to give an initial peak slightly in excess of full load current. As the speed and voltage fall, a voltage relay operates to force the shunt field with the result that the voltage and current are again made to rise. The voltage is maintained at approximately 500 volts down to the base speed of the motor. When the voltage drops to approximately 50 per cent of normal, a second voltage relay actuates a second contactor which shunts a portion of the braking resistance. The current again rises and the rate of deceleration is increased materially. The use of the second contactor reduces the total braking time by several seconds.

DISCUSSION

PRESENTED BY

R. T. GREER, Director of the Intersystem Power Utilization Bureau, Consolidated Gas Electric Light and Power Company, Baltimore, Maryland

J. A. CLAUSS, Chief Engineer, Great Lakes Steel Corporation, Ecorse, Michigan

L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Michigan.

E. G. SCHLUP, Electrical Engineer, American Rolling Mill Company, Middletown, Ohio.

G. E. SWIFT, Manager, Philadelphia District Office, Electric Machinery Company, Minneapolis, Minnesota.

R. T. GREER: As indicated by Mr. Schnure, the new mills have caused a substantial increase in the plant requirements for electrical power and energy. When these additional requirements were anticipated, the problem of how they were to be supplied was discussed with the Consolidated Company to determine whether Bethlehem would install additional generating equipment or purchase their capacity from

Consolidated. It was decided that it would be supplied by the utility and that the steel company would, as Mr. Schnure said, stick to its knitting and make steel.

At this time, Bethlehem was generating part of their requirements with the 45,000 kw. of generating equipment at Sparrows Point and purchasing the remainder of their requirements. The purchased power requirements were being supplied over two 26 kv. circuits from the Canton Substation at a frequency of 25 cycles. As much as 30,000 kw. had been supplied over these circuits but they were inadequate for the additional requirements. Then, too, with the passage of time and developments in the industry, 25 cycle service had become less desirable and it was agreed that the additional load would be supplied at a frequency of 60 cycles.

The magnitude of the connected load at Sparrows Point, an indicated load of 120,000 kw. with a daily power consumption of 2 million kwh., and the desire to maintain proper service standards brought us to a careful analysis of our system to determine the best manner in which Bethlehem's requirements could be supplied.

Figure 1 is a diagram showing the geographical location of the regional power resources available for the supply of the Sparrows Point plant. At the top above the Pennsylvania line is Safe Harbor. This plant went into service in 1931 and contains six 30,000 kw. units. This station is a hydro plant with Kaplan adjustable blade turbines. It is tied in with the Pennsylvania Power and Light Company and Holtwood by 66 kv. lines and also supplies single phase 25 cycle energy for the Pennsylvania Railroad electrification. About eight miles below Safe Harbor is the Holtwood power development. At Holtwood are a hydro station and a steam station. The hydro plant has a capacity of 111,000 kw. at frequencies of both 25 and 60 cycles; the steam station contains 2 units with a total capacity of 25,000 kw. This station operates at a steam pressure of 350 lbs. per sq. inch and a temperature of approximately 550° F. This station is operated with anthracite coal dredged from the river above the dam and produces power very economically. At Holtwood, there is also a tie with the Metropolitan Edison Company at York.

These stations at the north are all tied in to Baltimore. There are two 220 kv. lines from Safe Harbor to Baltimore. One of these circuits comes into the Westport generating station and the other circuit runs to the Riverside Substation. There is a tap on the Westport line at Ellicott City and a spur runs into Washington. In Washington are two generating stations, Benning, and Buzzard Point. The Benning Station has a capacity of 185,000 kw. contained in 200 lbs. and 400 lbs. sections. The Buzzard Point station is a new station of high efficiency, containing one 35,000 kw. unit with a second unit of the same size now being installed.

There are tie circuits from Westport to Riverside in Baltimore passing through the Gould Street generating station. The Westport station has a capacity of 157,500 kw., 40,000 kw. of which is at 60 cycles and the remainder 25 cycles. The Gould Street station has a capacity of 72,000 kw. at 60 cycles. This station uses pulverized coal and operates at a steam pressure of 400 lbs. per sq. inch and a temperature of 750° F.

Figure 2 is a schematic diagram showing the main connections between the sources of generating capacity and the manner in which the Sparrows Point plant is connected to the regional power system. The power requirements for Bethlehem's new mills were supplied by the construction of two 33 kv. circuits from River-

FIGURE 1—Geographical location of the regional power resources available for the power supply of the Maryland plant of the Bethlehem Steel Company.

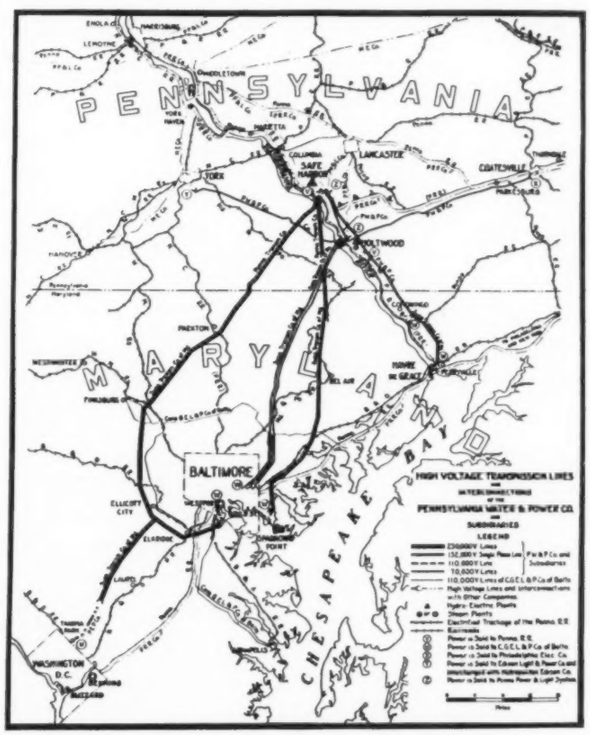
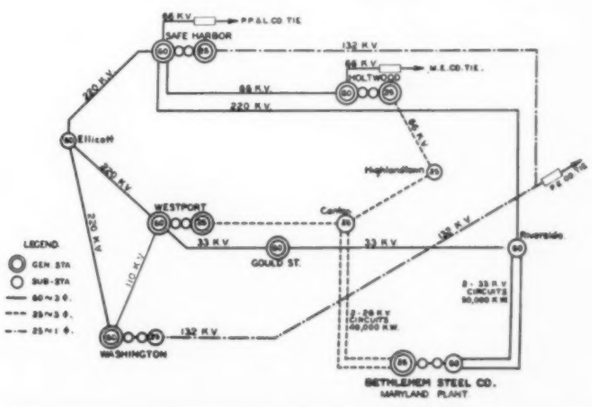


FIGURE 2—Schematic diagram showing the main connections between the sources of generating capacity and the manner in which the Maryland plant is connected to the regional power system.



side substation to Sparrows Point. These circuits are of relatively short length and are well backed with generating and transmission capacity. The transformers on the Safe Harbor-Riverside Line have a capacity of 126,000 kva. and the underground cables from Gould Street have a minimum capacity of 72,000 kva. The 25 and 60 cycle systems at Sparrows Point were tied with a 25,000 kva. frequency changer which serves as spare capacity for the 25 cycle system and also makes it possible to supply 25 cycle load at Sparrows Point from generation at 60 cycles. The other frequency changers on the regional system are also shown on this chart. Additional protection to the system is provided by ties with the Philadelphia Electric Company in connection with the Pennsylvania Railroad Electrification.

Some statistics in regard to the operation of the hydro plants may be of interest to you. The power house draft of one of the Safe Harbor units at full load is approximately 8,500 c.f.s. and the flow required for maximum output is more than 50,000 c.f.s. To show the magnitude of this amount of water, it may be said that the flow required to operate one unit is sufficient to supply the water requirements of five cities the size of New York or forty cities the size of Baltimore. During the floods in 1936, the flow of the Susquehanna River nearly reached 1,000,000 c.f.s. or a little less than 8,000,000 gallons per second. The water level behind the Safe Harbor dam has an elevation of 227 feet above sea level and the head on the turbines is approximately 55 feet. The pond above the dam has a storage capacity equal to about 6,000,000 kilowatt-hours which may be distributed to meet service requirements and affords additional protection to service.

FIGURE 3—The incoming 220 kv. line from Safe Harbor and the main transformers can be seen in this view of the Riverside Substation which is the source of 60 cycle supply for the Bethlehem mills at Sparrows Point, Md.

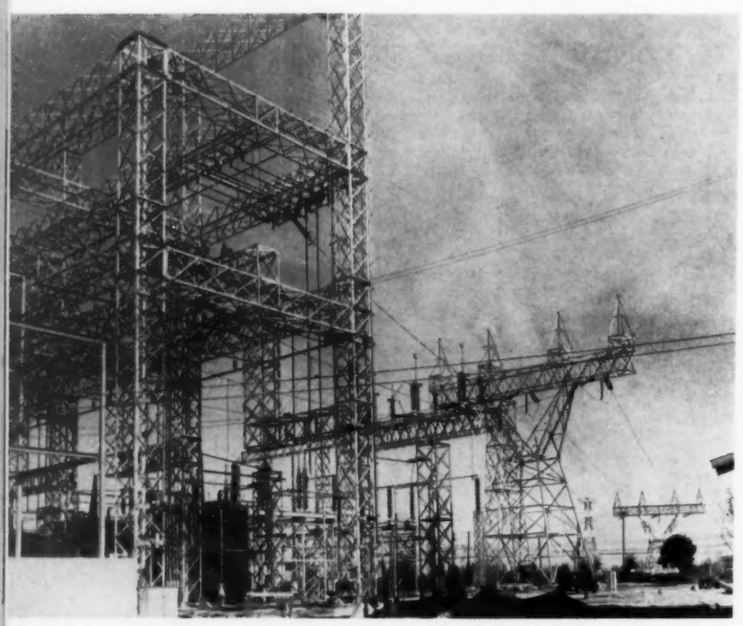


Figure 3 is a view of the Riverside Substation from which the 60 cycle service to Sparrows Point is supplied. The incoming 220 kv. line from Safe Harbor and the main transformers may be seen. The main transformers are single phase transformers of 42,000 kva. capacity, giving a bank capacity of 126,000 kva. A spare transformer has been provided to aid in maintaining continuity of service.

This general picture serves to show that the system from which the Maryland Plant of the Bethlehem Steel is supplied is a closely knit regional operating system, that is, it has high electrical stability. In other words, there is considerable generating capacity at many points throughout the area and all points are tied together with high-voltage, high-capacity transmission lines thereby giving a very rigid system which should give the best sort of service. It is obvious that a customer in this section is not dependent upon a single supply source but is backed by the power resources of the entire region.

The total installed generating capacity of this interconnected system is about 850,000 kw. The peak-hour load is approximately 550,000 kw. with a daily total load of more than 9,000,000 kwh. It may be seen that the load at Sparrows Point with peak loads in excess of 100,000 kw. and daily totals of more than 1,500,000 kwh. is an important part of the system load.

The general scheme of operation for the interconnected system is that when ample water is available the hydro units operate to carry the base loads while the steam plants carry the peak loads and that during low river flow periods when the available water will not permit operating the hydro plants at capacity for the entire day, the steam plants carry the base load and the hydro plants carry the peaks. The significance of this is that a high degree of cooperation between the various companies is necessary to obtain maximum overall economy together with good service. The Sparrows Point generating plant is operated as an integral part of this regional system.

We feel that the coordinated operation of the Sparrows Point plant as a unit in the regional power system is a real achievement which results in low cost and good service. We have appreciated working with the Sparrows Point people on this problem and have learned a great deal from them.

I wish to congratulate Messrs. Schnure and Wright on their splendid paper and thank them for this opportunity afforded us to discuss it.

J. A. CLAUSS: Mr. Chairman and Gentlemen, this discussion of Mr. Schnure's and Mr. Wright's papers was prepared by our Electrical Engineer, Mr. Loyal R. Milburn, who is a member of our Association. He was unable to come; somebody had to stay at home and work, so he asked me to read it for him.

I started this day off kind of bad. I don't as a rule get mixed up with electrical engineers. I had breakfast this morning with a bunch of electrical engineers and I told them that as a general rule I shun them like I do wild women, because every time I get mixed up with them it costs money.

I find these electrical engineers to be good salesmen. At our plant the electrical engineer has a great system. He will come in and tell me that he has to buy a little motor. I say "how much?" and he says "not much—

three or four hundred dollars" and I say "O.K.". A couple of days later he will ask me to sign a requisition for seven or eight hundred dollars for controls, and when I ask him what the control is for he says "why, for that little motor you signed a requisition for the other day". Again these electrical engineers get you to buy a limit switch for a machine, and if you don't watch them they will buy a second switch to protect the first one. I understand that all electrical engineers are the same.

Now, we mechanical engineers are not like that; when we stop a machine, she stays stopped. Seriously, now, I believe our electrical engineers are doing a very splendid job, but I would never tell them so. If I did, we would have to add another girder on our cranes. You know, we used to build cranes with two girders, but today we build them with three girders—one to carry the electrical control.

Last night I listened to a splendid paper and discussion on "Instrumentation of a Modern Hot and Cold Strip Mill". I want to warn the mechanical engineers that, if they don't watch their steps, the electrical, instrument and lubricating engineers will have our mechanical equipment so covered with devices of their own invention that the machine will lose its identity. I would not be surprised at all to hear in the near future of someone who bought a limit switch or a motor, a lubricating system and a temperature recorder and then first bought his mill. When it takes a staff of experts to keep the auxiliaries of a major piece of equipment in operation, we must be careful not to put the cart in front of the horse.

L. R. MILBURN: The authors of this paper have presented the subject in a very excellent manner.

This paper and the discussion which it should develop will prove of great value to the mill builder and to steel mill electrical and mechanical engineers for future installations of rolling mill equipment.

It is a problem to know where to stop when installing power plant equipment for a steel mill.

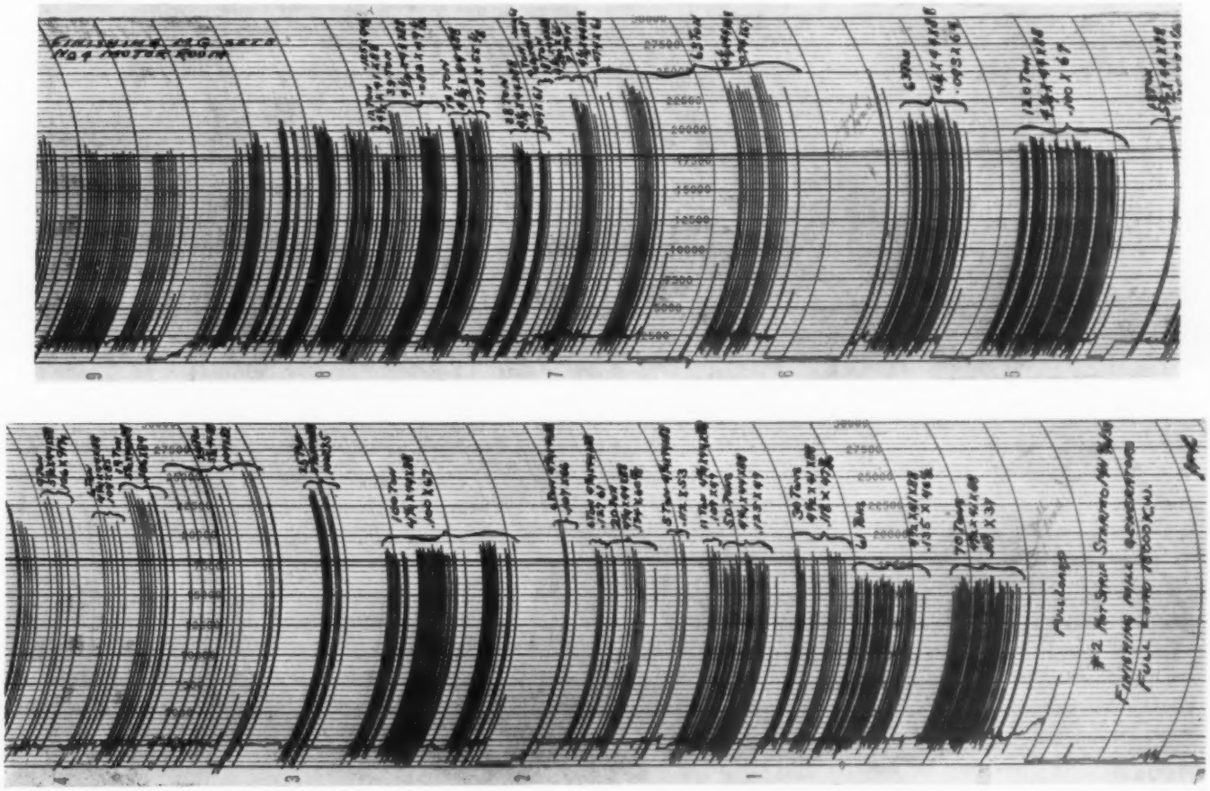
He is indeed a far-sighted engineer who can today tell us what our steel plants will be using in kilowatt demand and kilowatt-hours during the next two to five years. Therefore, all power supply equipment must be so arranged to allow for future expansion at a minimum expense. This seems to put a burden on the new installation, yet that is better than to have burdened the existing installation with excessive power supply equipment these many years.

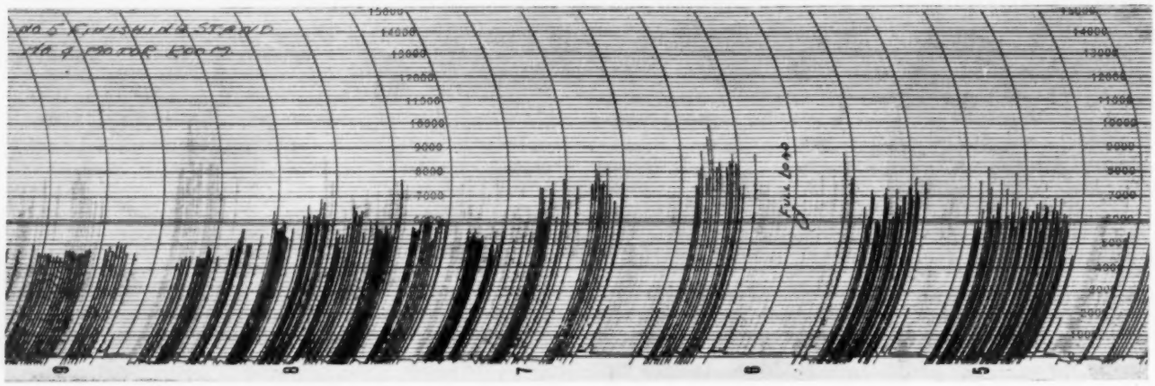
I note the figure of 82 kilowatt-hours per gross ton of slabs charged on your 56″ mill. This checks very close with our records at the Great Lakes Steel Plant on our 96″ hot strip mill. It would be interesting to know more about the unbalanced load on the 2—300 hp., a-c motors driving the rolls on the No. 1 scale breaker.

It is very interesting to note the application of synchronous motor drives on your roughing mills. You do not state the length of slabs used on your mill and I am wondering what will happen to the synchro-

CHART No. 1 showing the combined kilowatt load on the 3—6000 kw. 600 volt, d-c motor generator sets furnishing power for the finishing stand motors on the hot strip mill of the Great Lakes Steel Corp., Ecorse, Mich.

Charts Nos. 2 to 7, shown on the following three pages show the amperes pulled by the individual motors, stands 5 to 10 inclusive.





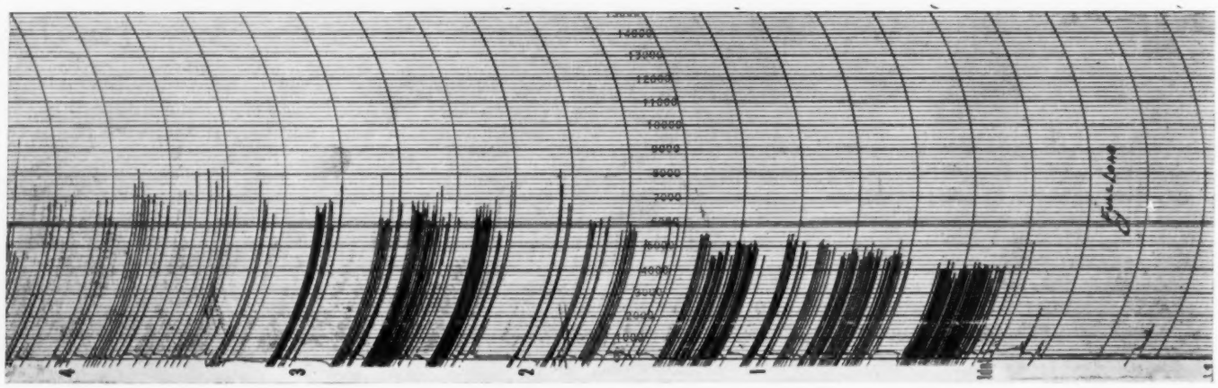
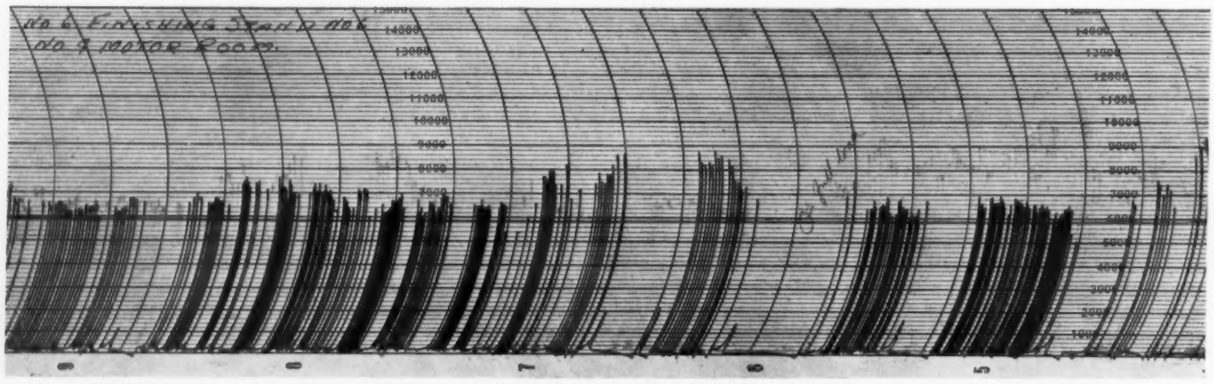
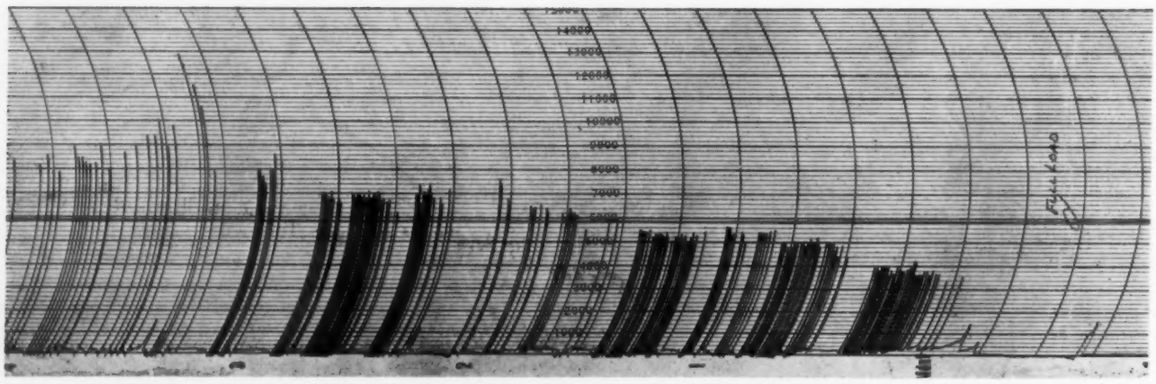
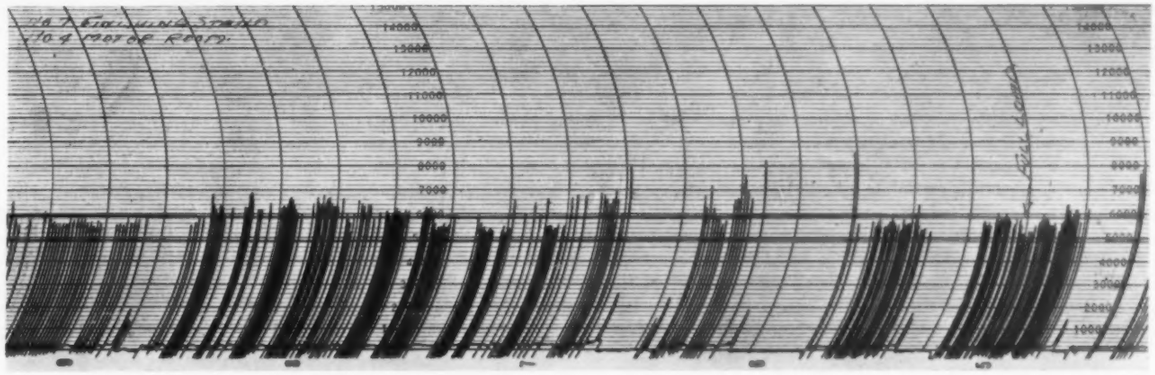


CHART 2—Above—Ammeter readings for No. 5 finishing stand.

CHART 3—Below—Ammeter readings for No. 6 finishing stand.







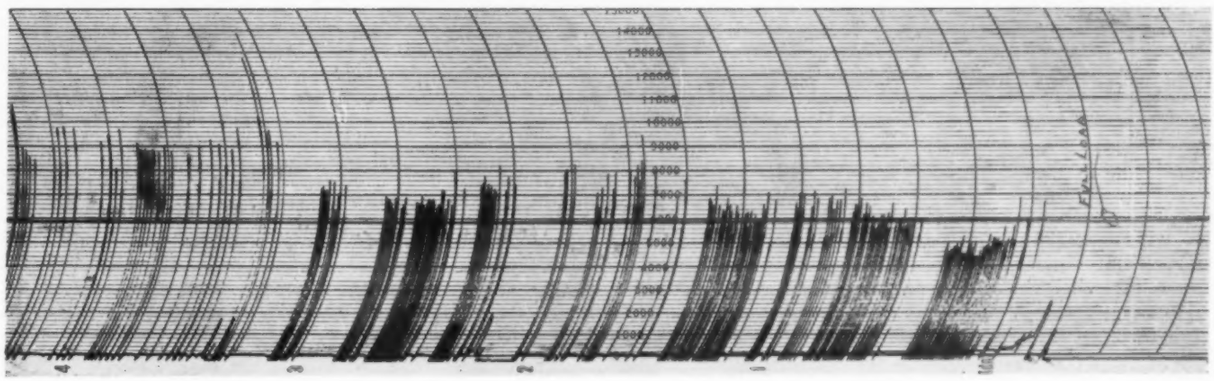
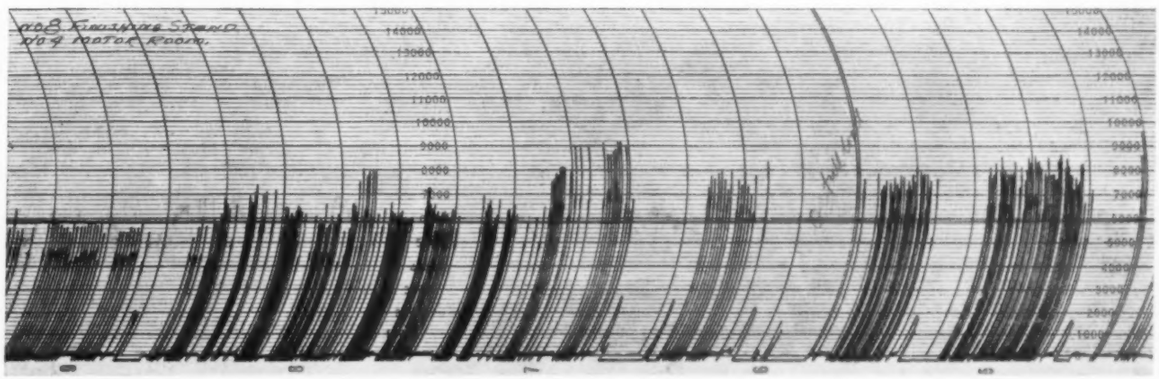
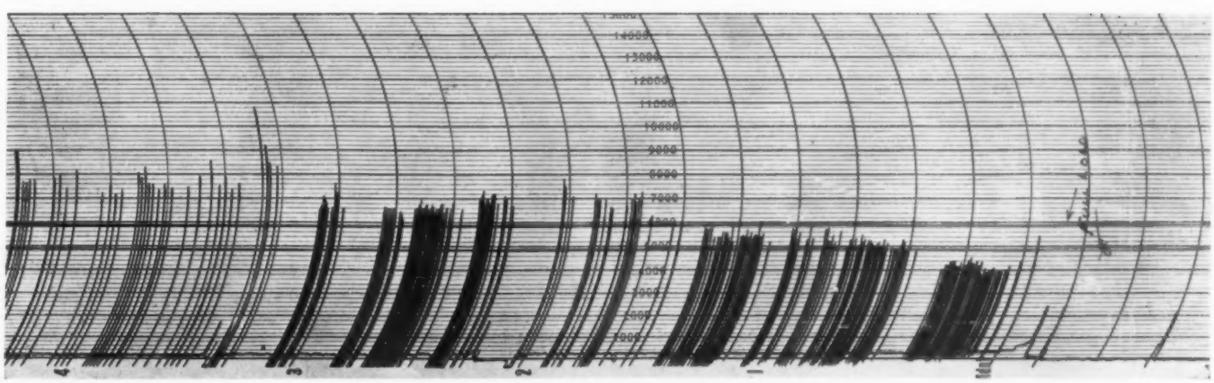
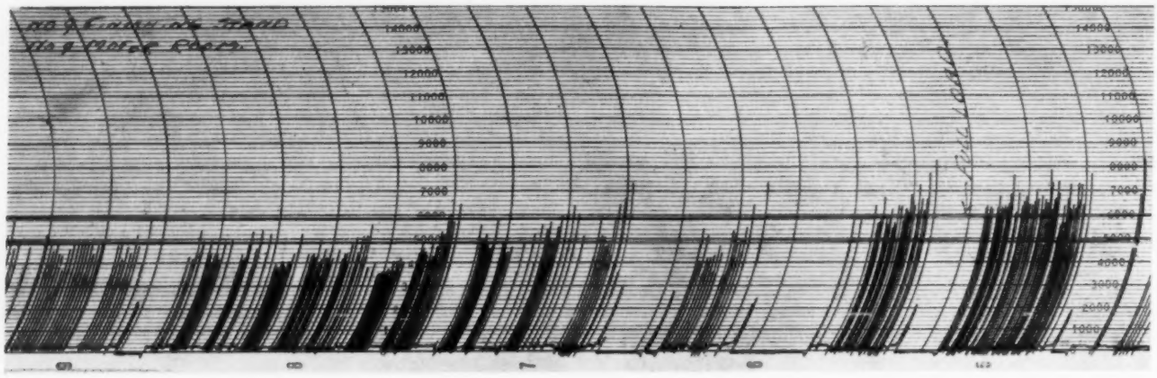


CHART 4—Above—Ammeter readings for No. 7 finishing stand.

CHART 5—Below—Ammeter readings for No. 8 finishing stand.







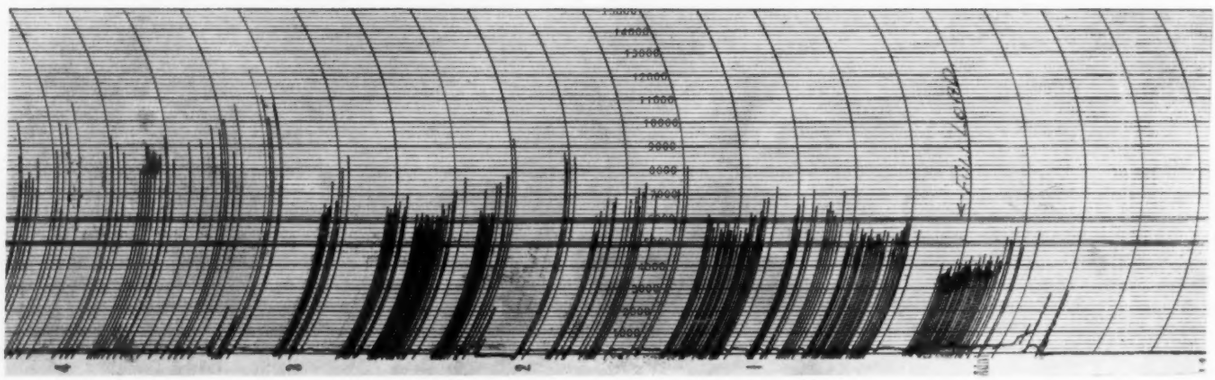
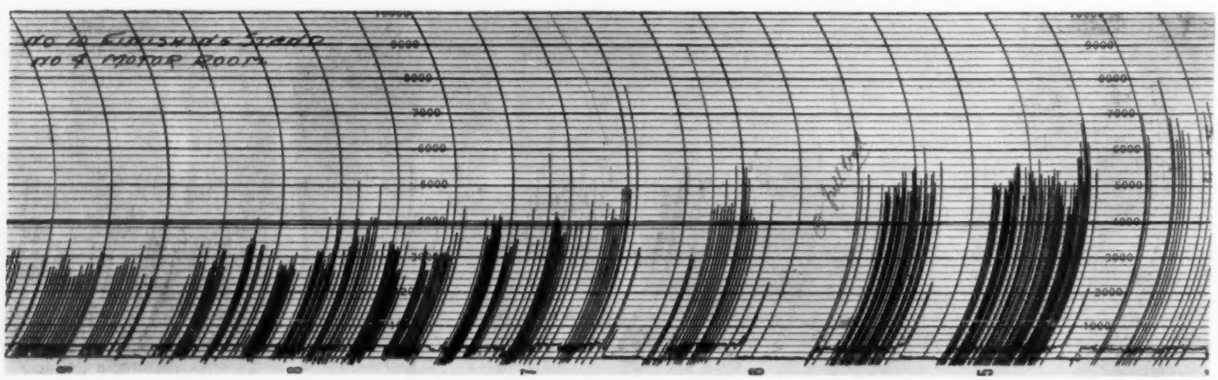
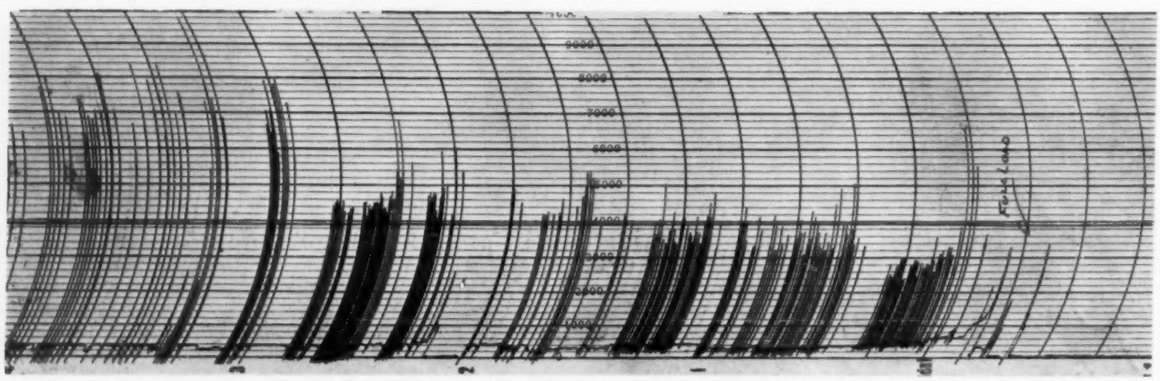


CHART 6—Above—Ammeter readings for No. 9 finishing stand.

CHART 7—Below—Ammeter readings for No. 10 finishing stand.





nous motors in the way of power peaks if you should roll 15 ft. slabs. Would these peaks be more severe than when using wound rotor induction motors with flywheels and slip regulators? What would these peaks mean to a power bill based on 15-minute demand cost?

I believe that the mill builder and the electrical machinery manufacturers should give this item more study, as the cost of synchronous machines would be less than wound rotor motors. It will also save floor space in the motor room.

The set of curves showing power load for your finishing mill is the first set that I have seen which shows the motors running at less than full load, whereas the set of charts which is herewith submitted shows our motors pulling considerable overload.

Chart No. 1 shows the combined kilowatt load on the 3—6000 kw., 600 volt, d-c motor generator sets furnishing power for the finishing stand motors.

Charts No. 2 to No. 7, inclusive, show the amperes pulled by the individual motors, stands 5 to 10, inclusive. Stands 5 to 9, inclusive, are each driven by a 4500 hp., 600 volt, d-c motor and stand 10 by a 3000 hp. motor.

These charts were made on April 7th, 1938. You will note that the thin gauges are the ones that require the power.

You bring out the fact that you use two-step dynamic braking on your finishing mill drive motors. We at Great Lakes heartily agree that all mills should have dynamic braking on the finishing mill drives. We have only one-step dynamic braking on the finishing stands of the 96″ hot strip mill at the Great Lakes Steel Plant. Our experience with this dynamic braking would lead us to believe that two-step dynamic braking should be an improvement. The one-step dynamic braking which we have has been of great benefit to our maintenance department. The time required to stop one of our finishing stands is from 8 to 10 seconds.

I think that the idea of using a camera to make readings of all instruments at once is an excellent one and will be of more and more use in the future for testing. No group of men could get simultaneous readings on as many meters so accurately.

I think that this is an excellent paper and contains much food for thought. I wish to congratulate the authors on a job well done.

Papers of this nature show the vital need for a test engineering department for every steel mill with sufficient meters and equipment.

J. A. Clauss: The layout of our mill with a detailed description was published in the September 1936 issue of the Iron and Steel Engineer and it might be well to refer to that when checking the curves submitted with Mr. Milburn's discussion.

Mr. Wiley asked me to supplement the data submitted with the speed, draft and temperature for the material being rolled when these power charts were taken.

Each of the charts is marked with the size of slab used and the width and gauge of strip rolled. I do not have the temperatures and draft at each stand; we do not have temperature recording instruments at each stand.

I checked with the mill and found that on the morning of April 7th between the hours of six and eight o'clock the mill was rolling an order of .060 x 67″ wide. The delivery speed was 1500 ft. per minute. The temperature of the slab out of the furnace was 2200° F. The temperature entering Stand No. 5, which is the first finishing stand, was 1900° F. and the temperature at the exit end of Stand No. 10 was 1500° F. One of the charts submitted covered this particular rolling.

E. G. Schlup: This is a very interesting and ably presented paper dealing with a timely subject. On several occasions, we have made extensive power studies in our own strip mill, the results of which were more or less applicable to local conditions only. However, we welcome the opportunity to plot the result of tests made in other mills onto our own power curves. The testing apparatus described is more elaborate than generally found in steel mills and therefore I am tempted to ask the authors to extend the present power studies to find the result of a number of studies generally not covered by a test made of a regular run of the mill. One intresting problem is to find the relationship of specific power consumption to various drafts at constant entering thickness of the strip, another for constant draft at varying entering thickness.

The nominal rating of the strip mill is given as 56″ but I am certain that Mr. Schnure will encounter no motor trouble to roll a 74″ strip of 0.093 finished gauge. Our 3,000 hp. motors have consistently pulled up to 7,000 amps. without overheating or commutator trouble.

Power demand limitations are imposed on some mills during day turns and if Mr. Schnure's mill is subject to such limitations, I would like to introduce the use of a power slide rule which I developed sometime ago for a local strip mill. And, contrary to general expectations, we found that the hot mill superintendent found use for such an instrument. This power slide rule permits a fast and accurate calculation of the 15 min. power demand of the strip mill for a large number of different rolling schedules. The rule is of circular shape and made up of five discs, three of which are on one side and two on the reverse side of the rule.

The operation of the rule is as follows: One disc selects the various grades of rolled steel, another disc selects the finished gauge ranging from 0.050 to .250, the third disc shows the kw./hr. consumption per ingot for slab width ranging from 20 to 80 in. After the kw./hr. value is determined on one side of the rule, this same value is selected on the first disc on the reverse side of the rule and finally through a window arrangement on the second disc the 15 minute power demand is read for rolling rates ranging from 3 to 10 ingots per 15 minutes. Thus with only three settings on the slide rule, the resulting power demand can be read.

Operating men in general, however, detest to be bothered with slide rules. In addition, we then installed a curve drawing demand meter at the bar shearing station which provides continuous control over the power demand from this key point of the mill.

(*Please turn to page 65*)

Electrical

By C. P. HAMILTON

Industrial Department

GENERAL ELECTRIC COMPANY

SCHENECTADY, N. Y.

Presented before the A. I. & S. E. Cleveland District Section, February 14, 1938

▲ A SKIP hoist bears about the same essential relation to a blast furnace as the auxiliary drives do to the modern mill. Thus the operation of blast furnaces naturally draws critical attention to the adequacy and dependability of the skip hoist in meeting the ceaseless demand for coke, stone, ore, and scrap, as long as the furnace is in blast. The new furnace construction, and particularly because of the greatly increased output that is being obtained, has correspondingly increased the duty of the skip hoist to the extent of requiring larger tubs and faster cycles together with a desire for flexibility in the operating speed. Skips serving these modern furnaces are, therefore, receiving most careful consideration of their ability to provide thoroughly reliable, long time operation with a minimum amount of maintenance and outage, together with means whereby operation can be carried on should some part of the system break down.

Before discussing the details of the recent developments in an operating system designed to incorporate these features to a greater extent than heretofore attempted, it would be well to obtain a prospective by first giving some thought to the bucket speed and then reviewing briefly the various systems of hoist drives and control that are in general use.

In a paper that the author had the privilege of presenting before the Chicago Section in January 1931, attention was directed to the fallacy of expecting that increasing the speed of skip hoists would result in a directly proportional increase in output. It was shown, as an example, that by increasing the speed of a given hoist from 400 FPM to 600 FPM or 150%, that the operating cycle time was only decreased to about 77% of the previous cycle instead of to 67% as might be expected by the amount of the speed increase. Therefore the most economical electrical equipment from the standpoint of skip speed only, and taking no account of structural considerations of the hoist, to meet the increased demands of the larger furnace is obtained by a compromise in the skip tub size and speed. Today skips operate at speeds from 400 FPM to as high as 700 FPM and since they must be slowed down to about

FIGURE 1—Control panel for two motor hoists operated by series-parallel rheostatic control used when skip speed does not exceed 400 fpm.

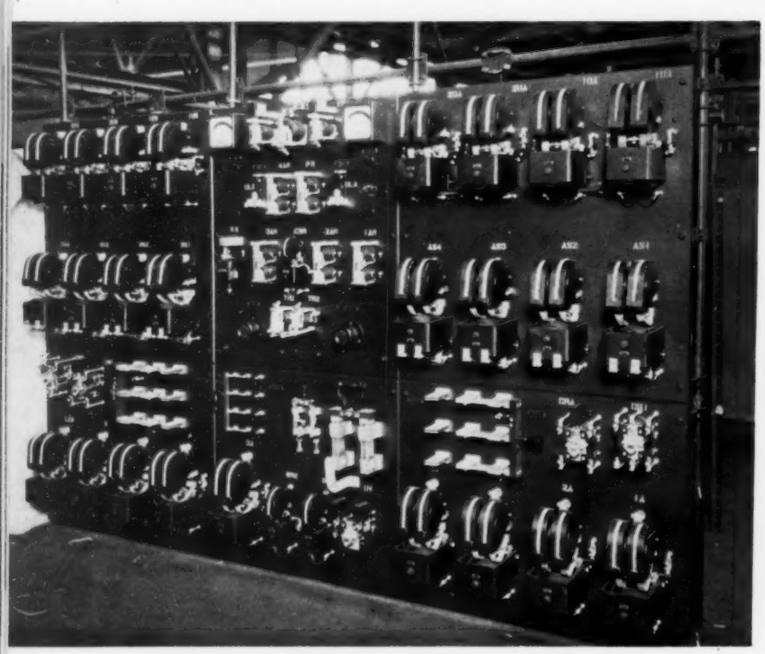
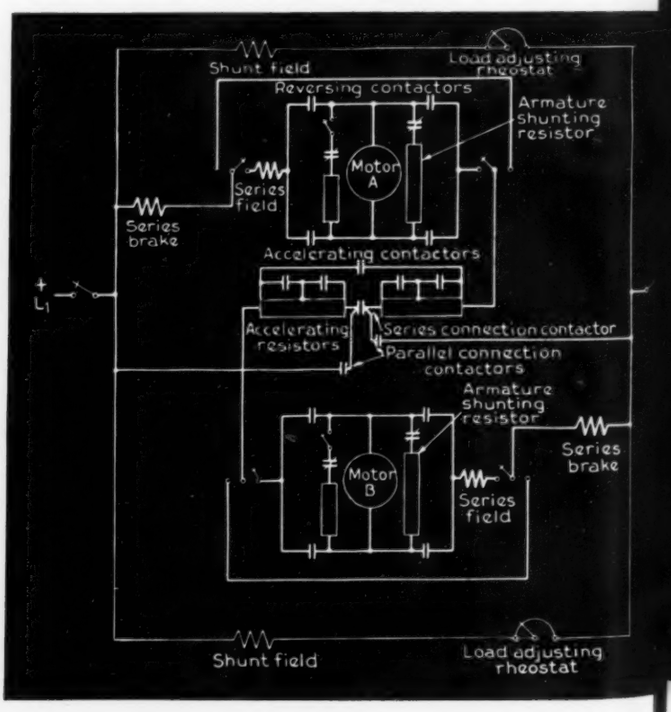


FIGURE 2—Elementary connections for series-parallel skip hoist control of two hoist motors, rheostatic control with provision for single motor operation.



Equipment for MODERN BLAST FURNACE Skip Hoist

75 FPM for dumping, the increased speed range means greater electrical problems. Increased skip speed is only an asset in reducing the operating time when the other elements in the charging system can keep pace with the hoist.

The capacity of the older types of furnaces was such that skip operating speeds of 350 FPM to 375 FPM were entirely adequate to meet all requirements with ample time to catch up in case of delay. Since direct current was so generally available, the use of rheostatic type control of single speed compound wound motors was common for operating skips at speeds that did not exceed these values, as the required slowdown could be readily obtained by armature shunting with a load selector control usually included so that ore loads and coke loads would dump at about the same speed. Some installations also used the two speed type of alternating current squirrel cage induction motors. Then we find two-hoist direct current motor operation entering into the picture using series parallel rheostatic control. This system resulted in better speed regulation than could be obtained by single speed motors for dumping, and it provided more torque per ampere of line current for backing the empty bucket out of the dumping knuckle. The two motor drive of the hoist also permitted single motor operation in an emergency.

In all three of these systems, the skip speed was definitely fixed and tended to make the hoist a bottleneck in the operations of the furnace in the event that the operating speed selected closely meets the require-

FIGURE 3—Elementary connections for single-hoist motor drive with single generator and generator voltage control.

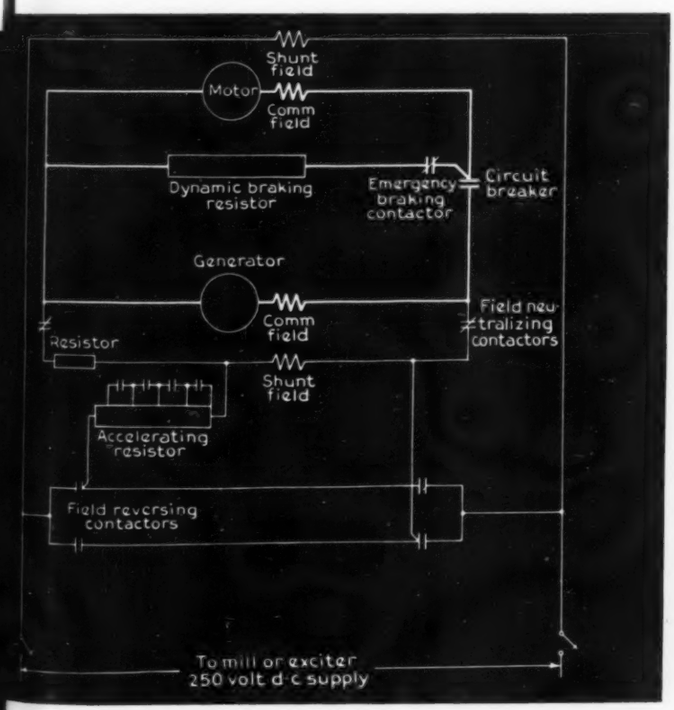
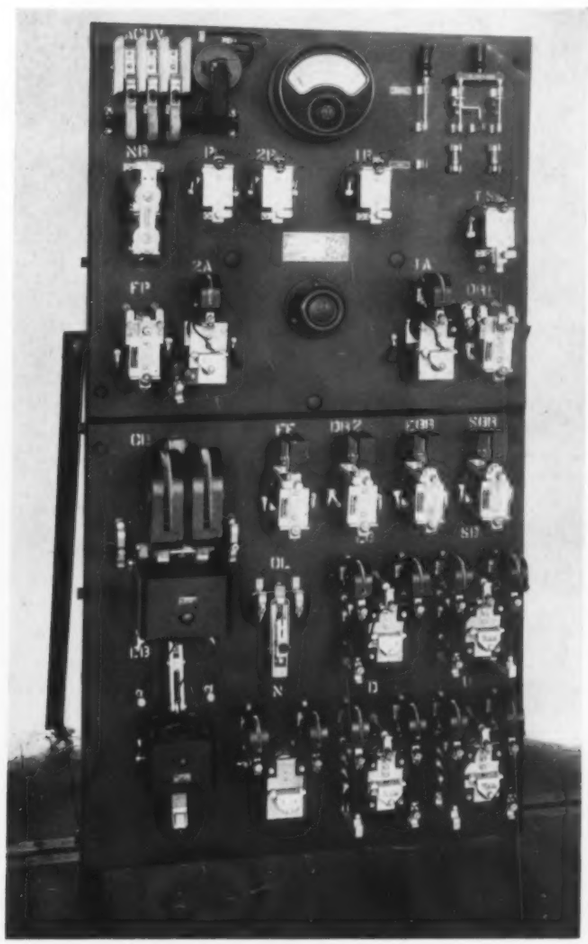


FIGURE 4—Control panel required for the single motor hoist drive shown schematically in Figure 3.



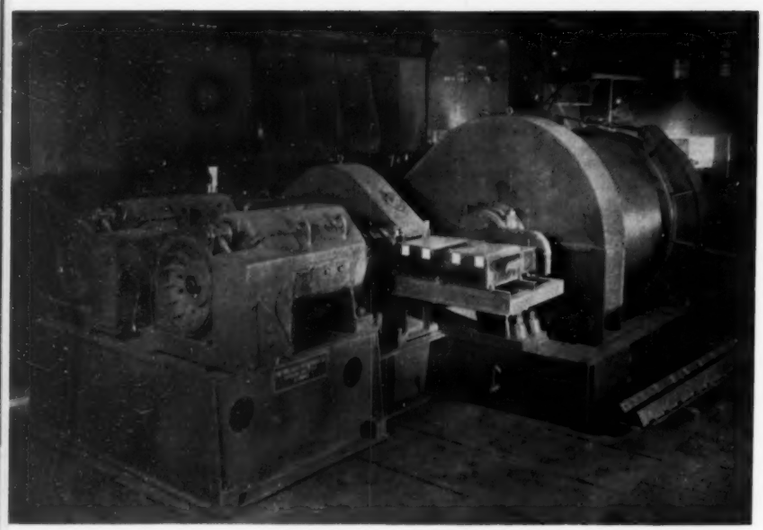


FIGURE 5—Two motor hoist drive with provisions in the connections for operating the hoist by the use of one motor.

ments of the furnace at the time of installation. Rheostatic control also has limitations in the amount of speed reduction that could be obtained by armature shunting and which also results in extremely poor speed regulation even at considerable waste of current through the shunting resistors. Therefore, when larger furnaces were erected and skip speeds increased, rheostatic operation of direct current single motor hoists required for completely successful operation, the use of motors which would provide a speed control range of two to one, or three to one, by field control in order to obtain the required slowdown speed for dumping by armature shunting. Thus today we find hoists of the newer furnaces operated by one of the following systems when rheostatic type of control is selected.

A. The use of single motor hoists with speeds which may be as high as 600 FPM. The motor with this type of drive provides a speed range of 2:1 or more by field control which will bring the skip speed down to 200-300 FPM from which the additional slowdown is obtained by shunting the armature.

B. The two motor hoists operated by series parallel rheostatic control are in general use when the skip speed does not exceed about 400 FPM. With this type of operation, the hoist slowed down to half speed by switching the motor armatures from a parallel connection to a series connection, and then the remaining slowdown speed is obtained by armature shunting. A control panel for a hoist using this system of operation is shown in Figure No. 1 and the conventional elementary wiring is shown in Figure No. 2 and from which it will be noted that provision is made for single motor operation.

These two types of control require large heavy duty contactors, 27 being necessary in the latter case for control of two 140 hp motors, and yet while the systems have definite limitations, particularly of the slow speed control, there are a large number in successful operation.

In the efforts to overcome the disadvantages of the rheostatic type of drive, we find in 1927 a definite trend toward the use of generator voltage control and two single motor drive installations were made with skip speeds of 400 FPM and one two-motor hoist drive with an initial skip speed of 520 FPM.

The scheme of connections used with the single motor hoist drive is shown in Figure No. 3 and required a simple control panel such as that in Figure No. 4.

The two-motor hoist drive of the general mechanical arrangement shown in Figure No. 5 has the additional advantages over the single motor operation in that provision is made in the connections for operating the hoist by the use of one motor. Also this arrangement usually permits the use of standard mill type motors, in many cases duplicate of motors which are used in other parts of the mill. The usual system of two-motor hoist drive with generator voltage control is connected as indicated in Figure No. 6 from which it will be noted that the two-motor armatures are connected in series to the armature of the generator. This scheme of connections, with the two motors in series, of course requires the generator characteristics to be such that approximately twice the motor rated voltage will be obtained to provide the required motor speed during normal operation and at the same time to have sufficient current carrying capacity for single motor operation. The generator meeting these characteristics is considerably oversize for normal operation of the hoist and therefore heating is practically negligible and long brush life is obtained due to the low current peaks and freedom from burning.

The general experience, on the part of the steel mill engineers, from the use of generator voltage control systems has been that very little maintenance is required, the duration of outages have been of relatively short time, adjustments are simple to make, and the flexibility of the system is a distinct advantage. Also there is an indication, though difficult to evaluate, that the system results in longer life of the mechanical equipment and ropes, due to the absence of any sudden shocks during acceleration and retardation.

From the number of hoists that have been installed since 1927, using generator voltage control, it seems very evident that the two motor type of hoist is by far the most popular drive. In continuing efforts to obtain as high degree of reliability as economically justified by each particular installation, there is at the present time being put into operation a system that is new to the skip hoist field. In this system a two-hoist motor drive is used but instead of the motors being connected to a single generator, each motor is connected to an individual generator. Both generators are driven by a single squirrel cage type induction motor, although completely independent motor-driven generators may be used if such an additional step is felt justified. These generators are the 3-field type providing a drooping voltage characteristic as shown in Figure No. 7 which has proven so successful in the operation of such mill auxiliaries as screw downs, side guards, etc.* Since the maximum current of the generator can be so easily selected, the torque of the motor is definitely limited to meet all necessary requirements of the hoist without

*Iron and Steel Engineer, May 1937.

resort to auxiliary devices. Also, this drooping voltage characteristic inherently makes each motor and generator unit share the load equally with the motors mechanically connected together. Furthermore, the system makes it possible to use economical hoist motor sizes. In other words, by applying twice normal voltage, as an example, to the hoist motor armatures and hence obtaining double motor speed, the normal horsepower rating is about doubled and yet the motor operating speed is well within mechanical limitations.

In the design of a complete system of this type, great flexibility is available since there is such a wide choice in selection of the operating voltage and hence the motor speed. Therefore, the gear ratios between the motors and hoist can be so selected that the maximum hoist load will at no time require excessive motor torque even during single motor operation under the most unfavorable bucket positions.

In order to adapt these several desirable characteristics of the three-field differentially series wound generator to skip hoist operation, a new type of control had to be worked out to obtain characteristics that would provide a speed for dumping the bucket that would be practically the same regardless of the load. The three-field generator is a most versatile machine and in combination with different motor characteristics, makes it possible to obtain many different operating results. For skip hoist operation, the maximum stalling current is selected by the maximum torque that the motors should be permitted to develop. This point is determined by the separate shunt field excitation of the generator. The maximum operating speed of the motor is then obtained by the self-excited shunt field excitation, adding to the flux produced by the separate excited shunt field to give the required terminal voltage. In order to reduce the motor speed for dumping the skip tub and at the same time flatten out the voltage curve to obtain an acceptable speed regulation, the self-excited field is reconnected during the slowdown operation to buck the separate excited field. The result of controlling the self-excited shunt field to boost or buck the separate shunt field flux is shown in Figure No. 7 and from which it will be noted that the family of curves focus at the stalling current point determined by the desired maximum torque point of the motor. The use of this characteristic means that a heavily loaded tub of iron ore will go through the dumping knuckles without any hesitancy at a speed of about 75 FPM, while the corresponding speed with a coke load will be about

FIGURE 6—Elementary connections for two-hoist motor drive with single generator and generator voltage control with provision for single motor operation.

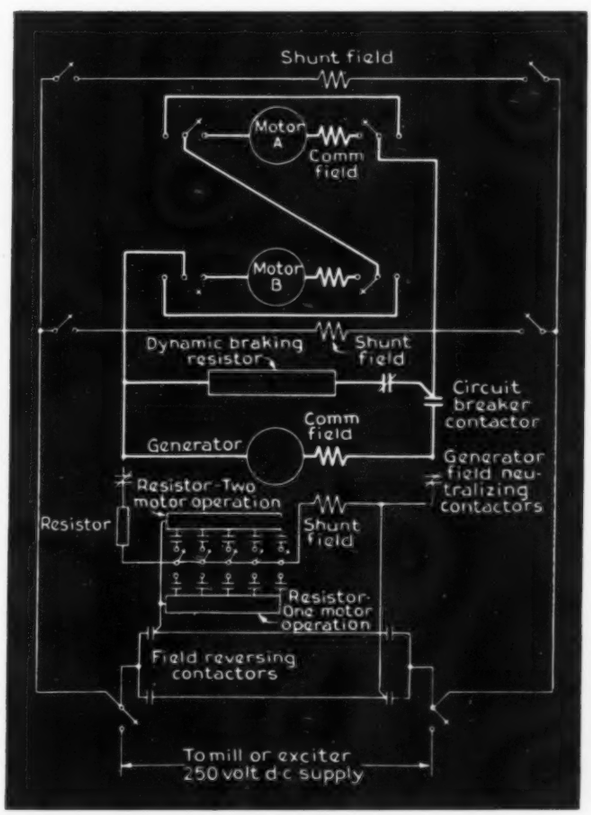
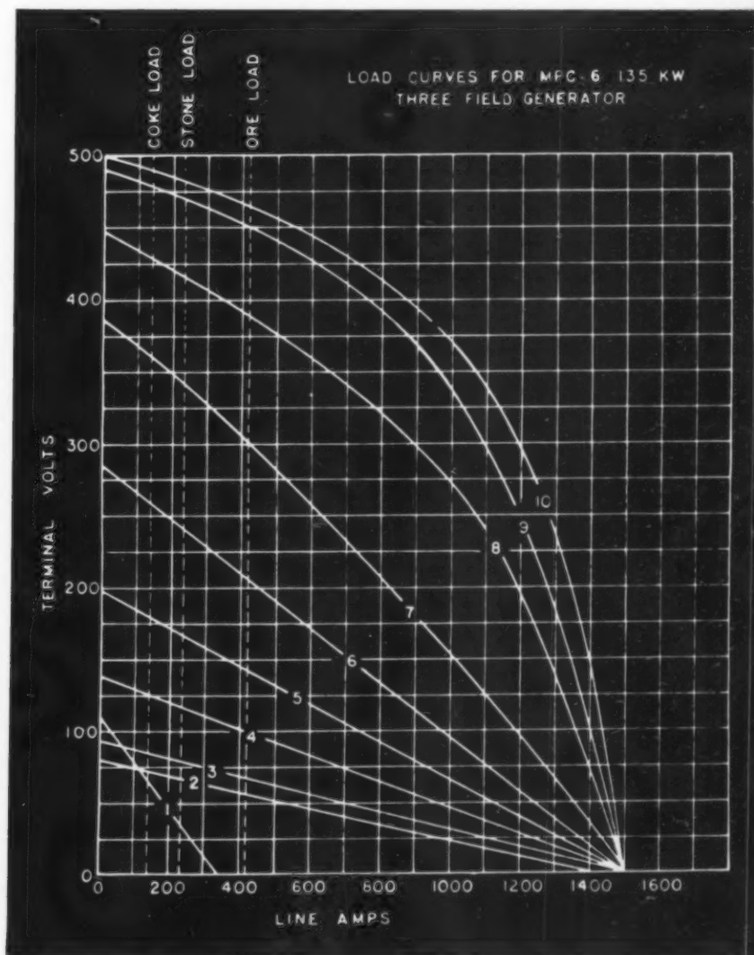


FIGURE 7—Load curves of the system using a two-hoist motor drive with each motor connected to a single generator.



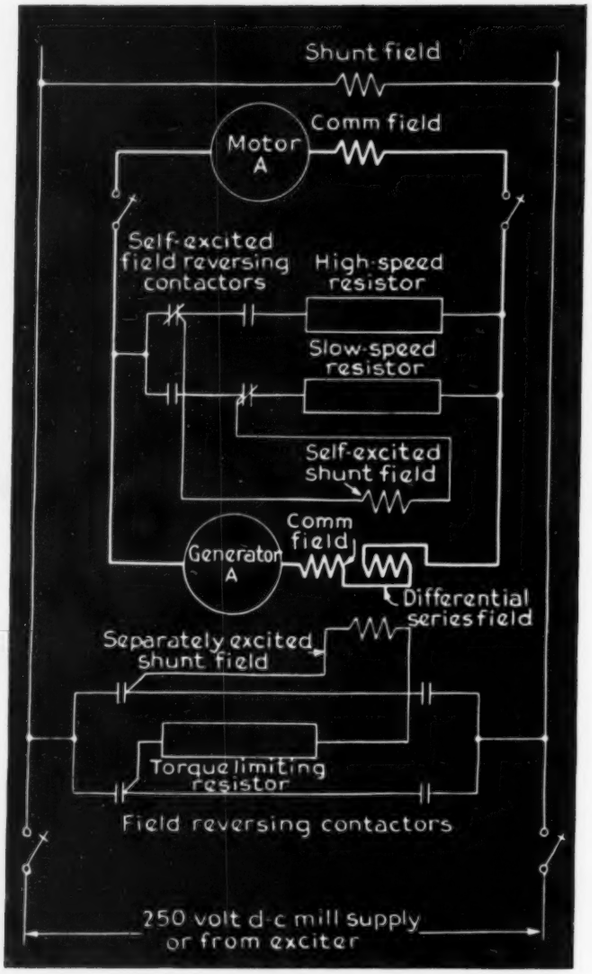
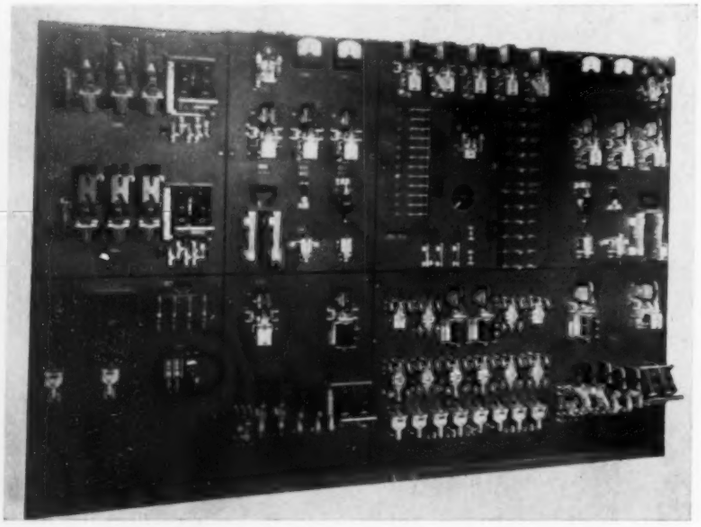


FIGURE 8—Elementary connections of one unit of a two motor—two-generator system.

FIGURE 9—Control panel used for the system shown in Figure 8.



90 FPM. Slower speeds may also be obtained with closer speed regulation. The coke and ore load speeds may be brought even closer together by a simple load selector control which will adjust the field strength of the generator to provide characteristics as indicated by comparison of curves No. 2 and No. 3 of Figure No. 7.

In addition to the advantage of flattening out the voltage curve for slowdown and keeping the stalling point the same for all operating points during acceleration, the system provides the further advantage that the motors will develop maximum torque quickly when the directional contactors close and before any of the accelerating contactors close. This means that the bucket when loaded with iron ore will readily start and yet a high speed, will not be obtained until the empty bucket is backed out of the dumping knuckle.

Among the characteristic curves in Figure No. 7, curve No. 1 is also shown which is used for inspection and oiling. From this curve it will be noted that the stalling point is pulled well in to limit the amount of torque that the motors can develop as a safety measure during the inspection period and also the maximum speed is limited to a low value.

The relatively simple connections of one of the two units of this system is shown in Figure 8 and a complete control panel in Figure 9. It will be readily apparent that such a system also offers the opportunity to provide completely duplicate control devices for the two units, as well as duplicate machines. However, in the design of the panels for the two installations that have been made, it was not felt necessary to carry the control duplication quite to the extent that is possible. Thus the separately excited shunt fields of both generators were controlled by common reversing contactors. Also the same relays for timing the acceleration and retardation, controlled the field resistance contactors of both generators.

In connecting the self-excited shunt field to buck the separate excited shunt field, to provide the required low voltage for slow speed operation of the hoist, conditions are already established for bringing the generator voltage quickly to zero as the self-excited field acts as a suiciding field immediately when the separate excited field circuit is open. This inherent control feature of the system means that the hoist will be brought to a stop electrically by the time the brakes have set so that they have but little to do outside of holding the hoist at rest. The armatures of the generators and motors remain connected together at all times with simply a knife switch in the circuit for isolation purposes.

While the accelerating peaks of the usual generator voltage control system reflected to the a-c. power system, is usually well within 200% of the full load power peaks even with fast acceleration, these peaks are very much less with the 3-field type of generator described, since the voltage has a more drooping characteristic. Since the maximum power requirements of this system are so definitely limited, the generator driving motor is operated well under its maximum torque rating with considerable margin available even during low a-c. voltage conditions.

(*Continued from page 59*)

I again congratulate the authors for the fine paper presented and hope that the discussions of their paper will result in another paper of this kind.

G. E. SWIFT: The authors are to be commended on their readable and interesting description of the power supply, motorization, and results obtained at this new, modern mill.

I will confine my remarks to some points concerning the synchronous motors on the roughing train that were brought out in the article.

Overall power factor of the hot strip mill, under load, as pointed out in the paper, usually varies from 97% lag to 97% lead. These desirable high operating power factors are a result, of course, of the preponderant amount of synchronous horsepower in the mill, approximately 30,000 horsepower.

In addition to the power factor advantage of synchronous motors for main roll drive, two other advantages are pointed out in the article that were factors in the selection of synchronous motor drives for the four roughing rolls. These desirable factors, as given, were simplicity of control, and lower overall cost, as compared with wound rotor induction motor drives. Other synchronous motor advantages that are also of importance in making the decision between synchronous and induction drive for constant speed mills are: The simple, rugged mechanical design, with large air-gap that can be achieved with a synchronous motor; a better electrical efficiency, the somewhat better adaptability of the synchronous motor to high voltage design, and better accessibility for ventilation.

Mention is made of reducing the excitation of the synchronous motors on the roughing train, at light loads to reduce motor losses and heating. This brings up the interesting subject of "field-forcing" or over exciting synchronous motors, driving main rolls such as the roughing train discussed in this article. This idea has been considered for years, and has been used in a limited way where conditions were suitable, but its application to synchronous motors handling sudden, intermittent, heavy peak loads seems still only a matter for interesting speculation.

The purpose of field forcing is, of course, to make possible lower first cost and lower losses, by use of a smaller motor which is capable for short periods, upon overexcitation of its field winding, of developing considerably increased pull-out torque. Conversely the field excitation could be much reduced when the motor was idling, or running under much reduced load, to reduce motor losses, and output of leading reactive kva.

The attractiveness of field-forcing lies partly in the possibility of utilizing a 20% to 30% smaller motor, depending on the duty cycle and load peaks, than is required where the motor operates continuously with excitation to develop its maximum rated pull-out torque. To this saving in first cost would be added considerably higher efficiency. Also the excessive output of leading reactive kva. that is poured forth by large synchronous motors running idle with high excitation, that is an objectionable situation in some mills, would be overcome.

In practice however field forcing has not been applied, so far as we know, to synchronous motors driving rolls such as those of the roughing train in this mill, where the motor handles a single stand and load is instantaneous and high. The problem is to provide means for maintaining and increasing the excitation rapidly enough to produce pull-out torque adequate to meet the sudden load. This involves not only development of a suitably fast acting control means, but also consideration of the source of excitation and the characteristics of the field of the motor itself. One possible answer to the problem seems to be some automatic means of anticipating the load. The value of such a field forcing sustem is such as to constitute a challenge to the electrical designing and application engineers.

F. O. SCHNURE: Mr. Clauss raised the question in Mr. Milburn's paper on what would happen when our mill rolled 15-foot slabs. We are rolling 15-foot slabs. He also wondered what would happen to a 15-minute demand when using synchronous motors instead of induction motors with fly wheels to absorb the peaks, and the answer to that question involves a number of considerations. We have an instantaneous demand which makes peaks more objectionable than when considered on a 15-minute basis. It is very true that fly wheels will reduce the peaks of an instantaneous demand, but not enough to compensate for the savings that come first, through the omission of fly wheels, the first cost being a sizable figure; second, it takes power to run them; third, the synchronous motor is more efficient than the wound rotor induction motor; and fourth, mechanical maintenance and lubrication on the fly wheel bearings is eliminated. However, the most important point is that on 15-foot slabs, fly wheels are of very little use, because practically all the stored energy in the fly wheel is used up in the first six seconds of a pass and steel is in No. 3 and No. 4 Roughers longer than that, in fact, in No. 4 about fourteen seconds.

The question raised regarding the starting of the frequency changer, when the MG set is not available is a pertinent one. We anticipated that situation and provided means to switch a circuit from the regular transmission system in order to connect the frequency changer directly to one of the turbines in the power house. The frequency changer can then be put on the line by any one of several methods of field and voltage application.

NEW Seamless

▲ A NEW mill for making 4½ to 14 inch seamless pipe, the first large seamless tube mill built in this country in over seven years, has just been put into operation at the Youngstown, Ohio, plant of The Youngstown Sheet and Tube Company.

The new mill is part of a general development and improvement program just completed in Youngstown Sheet and Tube's seamless pipe division which included the installation of a new 35-inch rounds mill for rolling round pipe billets, two huge "peelers" which automatically "skin" steel billets to remove surface defects, two new 50-ton-per-hour billet heating furnaces, the largest of their kind ever built, and two new pipe piercing mills that are masterpieces of engineering ingenuity.

Latest developments in design are incorporated in all the new equipment, from blooming mill to automatic pipe length recorders, which features to a far greater degree than ever possible before precise automatic control of operations.

So sweeping and revolutionary are the improvements of the new mill over anything that has ever been built before that it replaces a comparatively new mill built only twelve years ago. The new mill has a rated capacity of 300,000 tons per year.

The steel used in the manufacture of pipe on the new mill is especially selected open hearth steel. Ingots of this special steel are reheated in a battery of thirty-two soaking pits and rolled into blooms on a recently reconditioned 40-inch blooming mill. In addition to the new rounds mill, new equipment installed in this department included one 48-inch and two 72-inch hot saws, a 50-ton-per-hour billet reheating furnace and the two peelers.

In making billets 5¾ to 13½ inches in diameter, steel from the 40-inch blooming mill is rolled into rounds on the 35-inch rounds mill. In making 3¼ to 5¾ inch billets the larger rounds are brought back for further reduction. They are first allowed to cool, then are peeled, reheated in the new furnace and passed again through the rounds mill, this time to be rolled down to size suitable for finishing on a 24-inch merchant mill.

The new 35-inch rounds mill is a 2-high reversing unit with electric manipulators and a 4,000 hp. main drive. The mill has been designed for quick roll change with universal couplings that can be quickly retracted and pulled away from the rolls, and wide windows that allow the rolls to be easily removed.

The two 72-inch hot saws are identical units driven by 750 hp., 2,300 volts, 514 rpm. motors. The billets are clamped on the entering side while the saw is fed through them by electric power. Billets up to 14 x 16 inch can be handled by these saws.

The two peelers which take the large rounds after cooling on the cooling beds, remove the light surface cracks which heretofore were chipped out or scarfed by hand and expose the deep defects which show up as black marks against the bright surface of the newly cut metal. In this way all exploratory chipping to find deep defects is eliminated.

The two peelers are identical units with a capacity of approximately 1,000 tons per day each. The rounds are fed to the peeler by an entry carriage that clamps the back end of the round. An electrical drive in the carriage moves the round forward into the revolving cutters. After the billet has proceeded through the cutters to about half its length another gripper carriage on the discharge side of the machine moves up and pulls the round through. The clamping cylinders of both carriages are air operated.

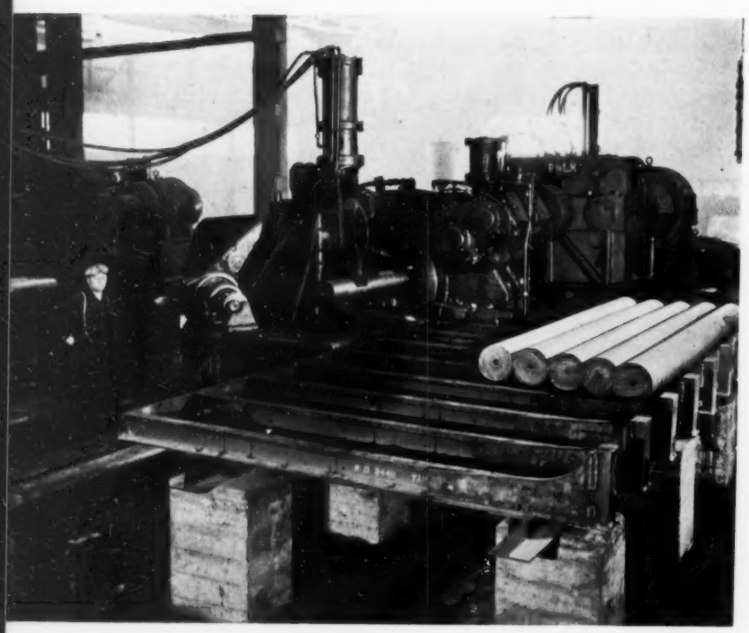
About one quarter inch of the metal is removed by the cutter head. Each unit consists of six hard alloy steel cutters fixed in a revolving jib. The main cutter heads are driven by 250 hp., 6 to 40 rpm. motors.

In the steel yard at the piercing mill the rounds are loaded on two 22 x 36 ft. loading docks, one in each bay of the building, and sent by roller conveyor to the billet reheating furnaces, which are continuous furnaces of the "walking beam" type. The furnaces are 25 ft. wide and 80 ft. long, the largest of their kind ever built. Each furnace has a capacity of 50 tons per hour.

The major portion of the steel is charged in the furnaces in double rows. Since most steel lengths fall between 8½ and 11 feet, the 25 ft. width of the double row furnaces makes for maximum coverage of the hearth. A very small percentage of the billets which are less than 8½ ft. long are made and fired double length and later cut in two. Steel up to 19½ ft. lengths can be charged into the furnace in single rows.

Each furnace has two heating zones, a primary zone 60 ft. long and a soaking zone 20 ft. long. In the primary zone, billets rest on skids of seamless water pipe fed by one of three possible water supply systems to prevent any failure. The billets are moved through this zone by four huge "walking" beams 60 ft. long. Two of these beams lift up the entire charge of billets

One of the two "peelers" which automatically "skin" pipe billets before they are reheated and rolled into pipe The peelers remove about inch of the metal, cutting off the light surface cracks which heretofore were chipped out by hand.



PIPE *Mill* *at* YOUNGSTOWN

in each row, move them forward and set them down again. This repeated action moves the billets through the furnace.

In the primary, walking-beam zone, billets are fired both above and below the pass line. Firing of billets from both above and below provides a uniform temperature which is of vital importance in making first quality pipe.

In the 20 ft. soaking zone billets are rolled on an inclined special refractory bottom where the heating to rolling temperature is completed and an absolutely uniform heat within the steel is assured. In this zone billets are fired above the hearth level only. Temperature in the furnaces is precisely controlled by automatic pressure controls and controls which regulate the air and gas ratio. Reheated billets discharged from the furnaces are sent to the piercing mills by a fast roller conveyor.

The two piercing mills which pierce the solid billets and roll them into rough tubes are masterpieces of modern engineering. Heavy main castings and extensive use of roller bearings combine to give these units extreme solidarity and stability and freedom from vibration never before possible on mills for such work. With these and a host of other improvements that make for increased speed and greater accuracy, operators can work to closer tolerances than heretofore possible on any mills of similar size. The main housings which weigh 119 tons each are the heaviest ever built for a seamless tube mill.

The two piercing mills are identical units. They are powered on the entering side by 5000 hp., 360 rpm. synchronous motors and have double reduction drives of pinion and single helical gears. Spindles are 16 inches in diameter.

Between the drive spindles and the drives are shear spindles and universal joints supported by a dummy stand for each unit. The shear spindles are each 5 ft. 10 in. long. All drive machinery is equipped with roller bearings. So, too, are the mill rolls proper.

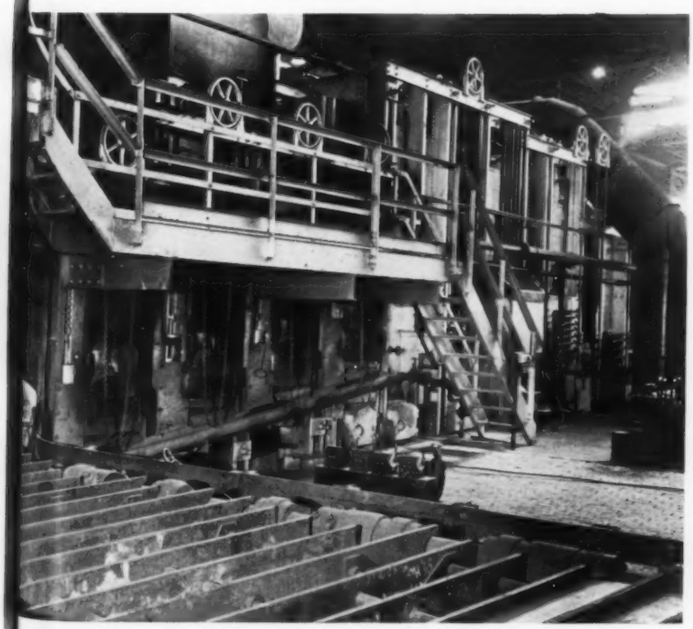
Construction and rolling principles used in modern continuous strip mills have been applied in the design of the piercing mills. The roll face is different from the conventional piercing mill permitting a different distribution of the actual working of the steel to give a better product than that made on other type mills.

Feed angle of the rolls, which governs the speed with which the billet is drawn through the mill, is adjustable to from 5° to 12° in either mill. The roll adjustment is motor driven through a typical worm gear drive.

Both inlets and outlets are longer than those on other mills, to permit the piercing of maximum lengths. This also reduces to a minimum the amount of work to be done in the high mill where the tubes are further rolled out and given a uniform wall of desired thickness. Inlet troughs are water cooled and slotted to take care of the scale. They are adjustable with hydraulic jacks.

Kick-off mechanisms which lift the billets and tubes out of the various troughs on to conveyor tables are all double-throw. The double kick-off arms which come up and make half a revolution with each operation

One of the two pipe billet reheating furnaces, each with a capacity of 50 tons per hour, are the largest "walking beam" type furnaces ever built.



The route of the white hot steel is from the furnaces—right rear—through the No. 1 piercer—right center—across and down the conveyor tables—center—and through the No. 2 piercer—left foreground.

Close-up of the No. 1 piercer where the solid billet of steel is rolled and pierced into a rough tube with wall many times as thick as that of the finished pipe.

continue around, always in the same direction. This cuts the displacement time in half and speeds up operations since it is no longer necessary to wait for the kick-off arms to return to their original position before feeding bars into the trough. The kick-off arms are designed to be easily removed to accommodate different length shells.

A pierced tube on the conveyor table between the No. 1 piercer—rear right—and the No. 2 piercer—front left.

Piercing mill bars are electric driven and equipped with automatic slow-downs and stops in both forward and reverse directions. The slow-downs and stops are adjustable to three positions to accommodate the different length shells made.

Piercing mill bars are of special alloy composition and have been fitted with special spherical type heads of Sheet and Tube development which will prevent excessive whip on the bar and excessive wear on the thrust block. Bars are water cooled and the water pipe is equipped with a bearing-type coupling to prevent breakage from twisting.

In making small size tubes the long piercing bar has a tendency to sag in the middle. To eliminate this sag, special carriers are provided to support the bars. They are synchronized with the bar drive and work automatically.

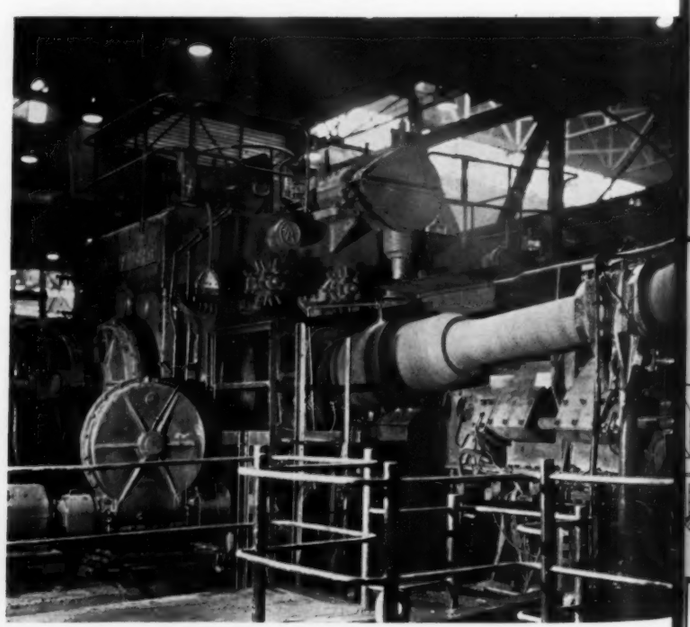
All main bearings, ways and movable parts are automatically lubricated, the furnaces and mills being equipped with central greasing and individual oil circulating systems.

Sirens are located on the operating platforms to signal the mill should any failure in the lubrication or water systems occur. Selsyn controls permit the cooling table operators to signal the men at any other unit should any other difficulty develop or any defect appear on the pipe. This will enable the foreman to make immediate adjustment.

The length of every section of pipe is automatically recorded at the cooling table. By means of Selsyn controls this measured length is also transmitted to an indicator in front of the roller at the high mill permitting him to closely check the foot-weight of the pipe.

Pipe made to specifications requiring normalizing is normalized in a new two-zone walking-beam normalizing furnace. This furnace is wide enough to handle 50 ft. lengths. It is 45 ft. long and has a capacity of 50 tons per hour.

Rear view of one of the two new tube piercing units showing the spindle drive. These units are each driven by 5000 h.p. 360 r. p. m. synchronous motors.



"UPSIDE DOWN" DAM FOR FLOOD CONTROL IN PITTSBURGH INDUSTRIAL VALLEY

▲ The first major "upside-down" dam for flood control is now ready to protect the vast industrial district along the Turtle Creek valley, a few miles east of Pittsburgh, from backed up flood waters of the neighboring Monongahela river.

In a recent test, engineers of the Westinghouse Electric & Manufacturing Company dropped a massive steel gate into place against the river bed and started two of the battery of three vertical pumps churning the water on its course downstream.

In actual operation this dam, costing more than a half million dollars, will cut two floods in the middle by two steel gates. First, the down-flooding water of Turtle Creek will be walled in; then, the backed-up slack water from the Monongahela will be walled out before it starts a counter attack up the valley.

With the approach of the next flood, two steel gates will be lowered across the valley. The larger, 80 feet long and 30 feet high, will be lowered across the creek. The smaller gate, 40 feet long and 20 feet high, will close the highway which parallels the creek. They can be lowered on anti-friction rollers from their normal carriage position 20 feet above the stream and the highway.

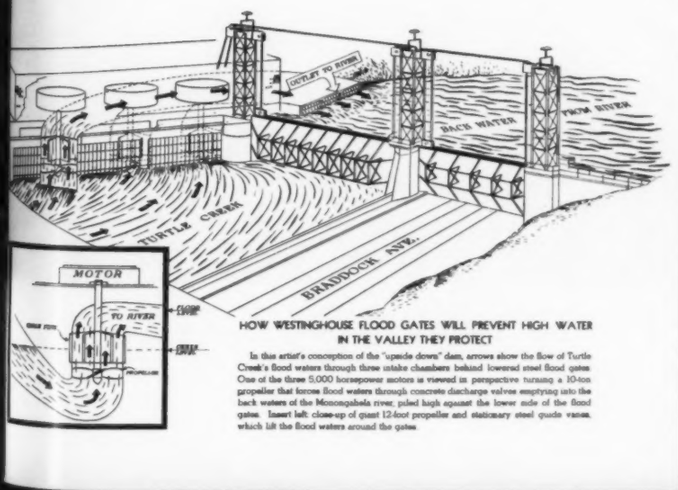
Three 5,000 horsepower electric motors rotate the pumps 112 times a minute. Each motor is 23 feet in diameter and is installed on the east side of the creek above high water level. They connect by 30-foot steel shafts with 10-ton propellers 10 feet below. A metal guide vane of four six-foot blades, placed above each pump, breaks up the stream of water into four paths to prevent eddies and increase the efficiency of the pumps. Each vane weighs 47,000 pounds.

From the creek above the dam the flood water pours into three entrance ducts and rushes down a sharp incline to pumping pits 11 feet below the creek's normal surface. The propellers then spin the water upwards through vertical wells from which it is deflected into horizontal chambers which permit the flow to expand gradually and reduce its velocity before it is emptied from the outlets on the downstream side of the dam.

When the water below the gates is only three or four feet higher than the upper water, these pumps will be capable of blowing 7,500 cubic feet of water a second. When the level difference increases, say about 10 feet, the combined capacity of the pumps will be reduced to 6,600 cubic feet of water a second—still more than enough to handle the flow of the creek which slackens as the water rises in the Monongahela.

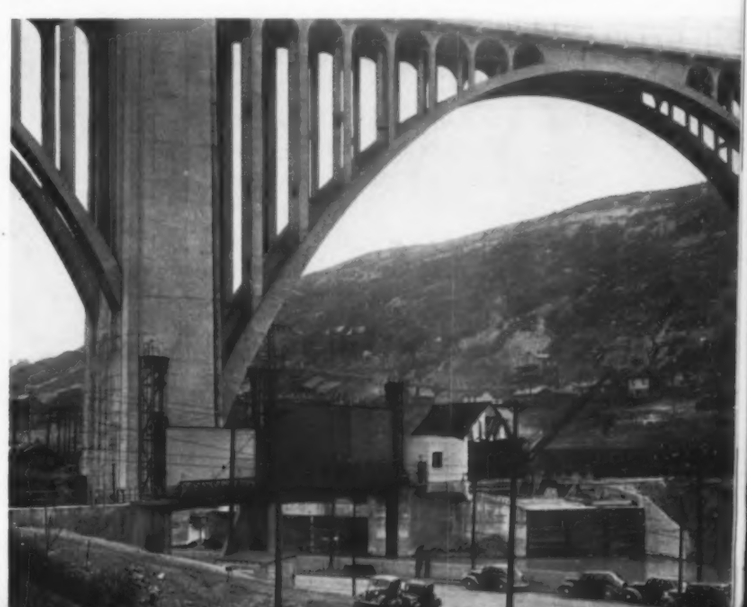
Engineers have learned that about

Lower left is an artist's drawing of the "upside-down" dam. At the right is an up-stream view of the dam with the gates in normal position. The water outlets on the down stream side of the dam are visible at the left side of this illustration.



HOW WESTINGHOUSE FLOOD GATES WILL PREVENT HIGH WATER IN THE VALLEY THEY PROTECT

In this artist's conception of the "upside down" dam, arrows show the flow of Turtle Creek's flood waters through three intake chambers behind lowered steel flood gates. One of the three 5,000 horsepower motors is viewed in perspective turning a 10-ton propeller that forces flood waters through concrete discharge valves emptying into the back waters of the Monongahela river, piled high against the lower side of the flood gates. Insert left: close-up of giant 12-foot propeller and stationary steel guide vanes, which lift the flood waters around the gates.



24 hours after Turtle Creek has carried the crest of its own flood waters, it is piled back upon itself by the Monongahela into which it flows about a mile and a half below East Pittsburgh.

With the gates closed during a flood, the pumps will quicken the flow of the creek through tunnels round the barricade.

Normally only a little more than two feet of water eddies over the bed of Turtle Creek which is 722 feet above sea level. But at high water this depth increases by more than 10 feet.

"The project is designed to handle the flow of the Turtle Creek even when the Monongahela is higher than 738 feet above sea level", explained J. E. Webster, Westinghouse general works engineer. "At this level the river stage is 31 feet 3 inches above Lock No. 2 in the Monongahela. Our records of past floods indicate that the maximum flow of the creek precedes by at least 24 hours the high water in the river. When the river has reached a stage above 31 feet 3 inches, the flow in the creek has decreased to not more than four or five thousand cubic feet a second".

By first lifting the water up the pump shafts 16 feet above the outlets, the pumps create a siphoning effect which helps pull additional flood water up through the chambers.

"The only effect of the barricade downstream", stated Webster "Will be that by pumping the flow beyond the gates, more water will be put into the Monongahela during the time its stage is rising, bringing the river to its crest a few minutes earlier than heretofore".

In the 1936 flood, it has been estimated, approximately 20 per cent of the additional water flowing into Turtle Creek during the rising period remained in the valley, unable to flow downstream until the Monongahela had absorbed its slack water.

Slightly more water, therefore, will be pumped downstream during the period of rising water than would normally flow past the site of the barricade, preventingthe water level above the gates from rising.

SAFETY FEATURES OF JONES & LAUGHLIN'S NEW HOT AND COLD CONTINUOUS STRIP MILLS

▲ That safety pays dividends has been proven time and again in the plants of the Jones & Laughlin Steel Corporation since the inauguration, in 1926, of a separate department devoted to safety engineering.

Dividends in management's knowledge that their employes are safe and comfortable while at work—dividends by increasing efficiency and improving employe relations—dividends by eliminating damage to valuable equipment and materials—dividends in the form of actual cash savings, by eliminating accidents that in the past led to expensive lawsuits or payment of compensation because of personal injuries to employes—these dividends have all accrued from a well planned and efficiently managed safety program.

The least tangible of these dividends is the increased efficiency of workmen in a safe plant as compared to workmen performing tasks where part of their minds are occupied with fear of possible injury or even death. However, actual studies show that workmen in a safe plant will produce a better product and a greater volume of that product than the same workmen will produce under dangerous working conditions.

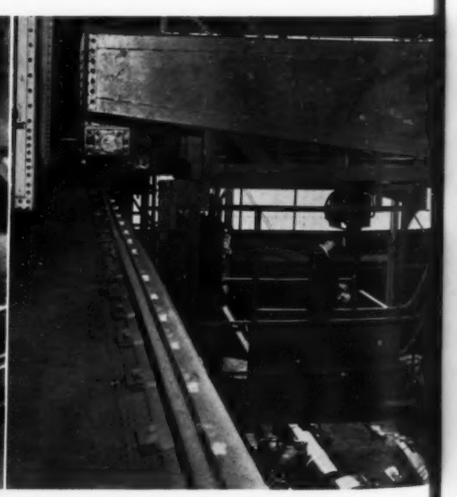
The new 96-inch continuous strip mill completed last Fall by Jones & Laughlin was constructed with these facts in mind and the safety factor was considered in all details of the mill and buildings. As a result of this careful planning, the mill was acclaimed by safety engineers during a recent visit as one of the safest mills they had ever seen.

When plans were being drawn for the construction of the mill, safety engineers worked side by side with designers to make certain that: First, the buildings that house the mill would be safe; second, that the mechanical and electrical equipment would be so guarded as to make for absolute safety; and, third, that the general layout of the mill would be such as to facilitate its operation and the handling of material in the safest possible manner.

Space does not permit mention of all safety equipment, but a few of the unique features of the mill are notable. The strip mill consists of twelve buildings grouped together as one unit which extends for about a half mile along the Monongahela River and covers a site of more than 23 acres. The buildings are of the sawtooth type with windows on the high side facing North for the best possible daylight. In order that these windows can be properly and safely cleaned on the inside, metal walkways with railings have been provided the length of each building. Access to

Good lighting is conducive to safety and this cut-up unit located in the cold mill finishing department and measuring 12.0 foot candles is typical of the good lighting throughout the new Jones & Laughlin mill.

Minimum clearance of 15 inches between crane trucks and face of building columns is another safety feature of this new mill. Crane access platforms are reached by railed stairways and bridge-walks.



these, and all other overhead walkways, is by stairs rather than fixed or temporary ladders. Stairs and walkways are also provided as means of access to gutters on the outside of the buildings, and to the roofs as well.

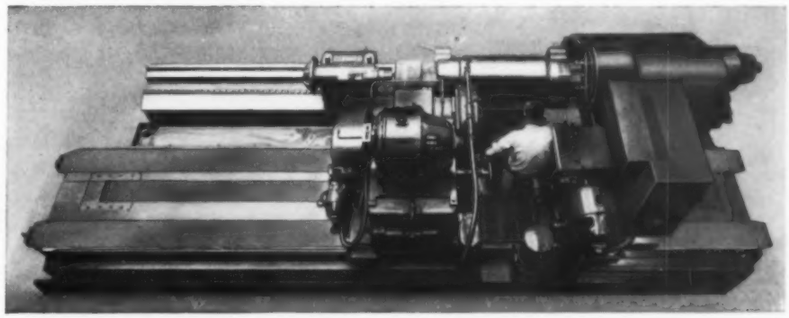
Good lighting is not only conducive to safety, but is an incentive to production of high quality material. In addition to the large windows mentioned, careful consideration was given to the artificial lighting requirements of the various departments where the light, measured in foot candles, is as follows: Hot Mill Finishing, 12.5; Plate Finishing and Shears, 12.2; Blue Annealing, 8.0; Slab Yard Chipping, 30.0; Roll Shop, 9.5; Cold Rolling, 10.8; Cold Mill Finishing, 12.0; and Cold Mill Shipping, 9.1. These figures represent the average light in each department. Special lighting is, of course, provided for certain finishing operations and inspection stations.

Overhead electric cranes have always constituted a serious safety hazard, and special attention was given this problem in the building of the Jones & Laughlin strip mill. In the past, many workmen have been permanently injured or killed when caught between the end trucks of moving cranes and building columns. The safety engineers eliminated this hazard in the strip mill by having the crane truck supports designed to provide a minimum clearance of 15 inches between the end trucks and the face of the building columns. This added $40,000 to the construction cost of the building, but, because of the additional measure of safety, it is considered money well spent.

Characteristic of all strip mills, overhead electric cranes are used here to transport loads weighing as much as 75 tons for distances of several hundred feet. In the past, many loads have fallen because of failure of brakes on the motor shaft, so upon the recommendations of the safety engineers, all cranes in this mill have extra brakes installed on the jack shafts providing additional protection to equipment and workmen.

All power transformers and starting reactors are insulated by pyranol instead of oil, which eliminates a fire hazard and at the same time, makes for safer operation. The towers which support the electric cables coming from the power plant have been designed with a partition in the center, making it possible for electricians to work on the dead side of the line without coming in contact with the live circuits.

The management of Jones & Laughlin, through the safety department, has done everything possible with physical equipment to make this mill safe. Realizing that mechanical safeguards, careful planning and expensive safety equipment are not enough if workmen are not safety conscious, the company continues its program of safety education through means of safety discussion classes with the foremen, and also by the use of conspicuous signs, posters, and bulletin boards in the mill. The company also holds safety meetings of employes, sponsors safety contests, distributes a safety leaflet from time to time and supplies workmen with printed safety rules applicable to their particular job in the never-ending effort to make safety pay dividends.



ROLL FINISH *and* CONTOUR

The Farrel crowning and concaving attachment produces a mathematically accurate curve of correct shape for either a crowned or concaved roll, exactly symmetrical on both halves of the roll. The same setting invariably produces exactly the same curvature and permits fixed, uniform and easily controlled accuracy of contour in all rolls.

The finish of roll surfaces and the accuracy of crown shape are important factors in the rolling of sheet and strip with the quality of surface smoothness and the uniformity of gauge demanded by modern requirements.

Many rolling mill operators insure the quality of their output by grinding their rolls or having them ground in Farrel Roll Grinders. These machines are designed to grind rolls of any material to any desired finish which can be obtained with wheels at present available, with a perfect surface free from marks of any kind and with straight, concave or convex contours ground to exact symmetry and accuracy.

In addition to substantial savings in roll finishing costs and in longer roll life, the control of roll accuracy and finish permits control of the quality of flat rolled products, assures uniformity of gauge and diminishes the quantity of sub-standard product.

Our Bulletin No. 111 describes in detail the various features of design and construction which are responsible for the superior performance of Farrel Heavy Duty Roll Grinders. Copies will be sent free on request without obligation.

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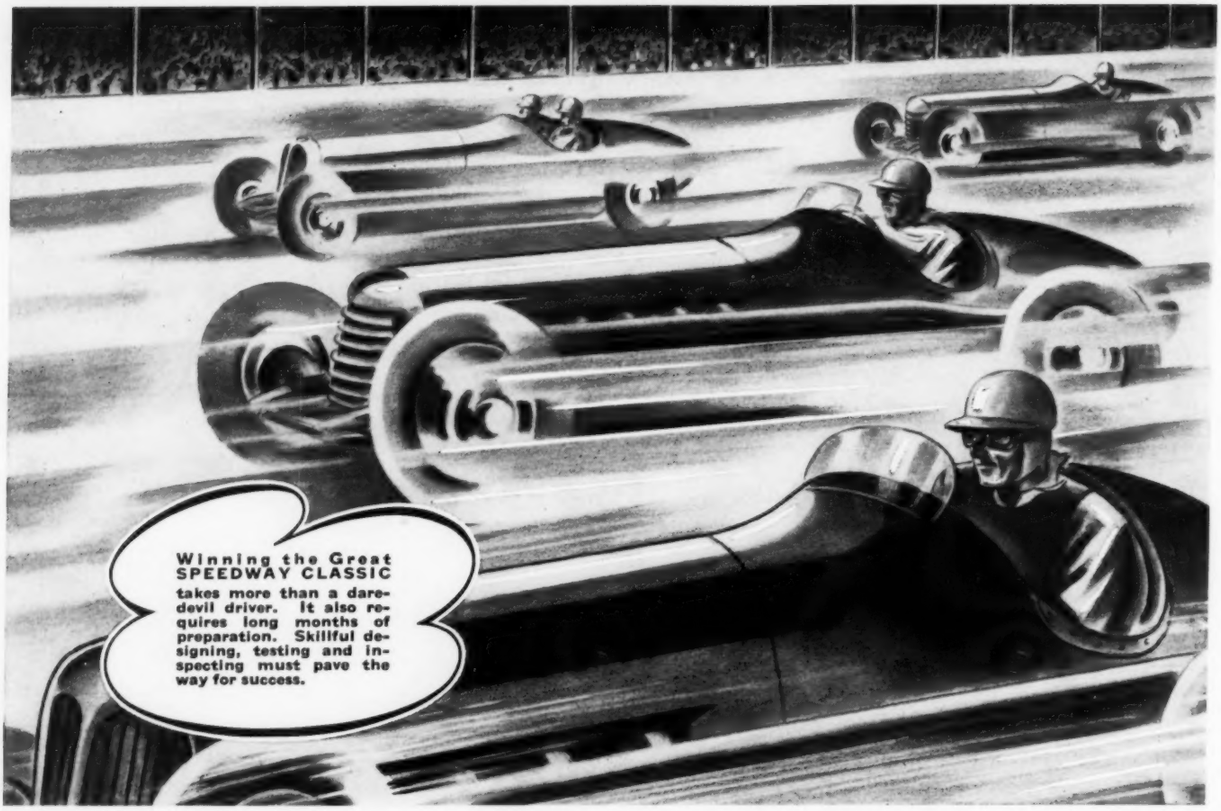
Winning the Great
SPEEDWAY CLASSIC
takes more than a dare-devil driver. It also requires long months of preparation. Skillful designing, testing and inspecting must pave the way for success.

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Bantam 4-Row Tapered Roll Neck Bearing. Bantam Bearings of this type are making outstanding production records in the steel industry. Being used in increasing numbers in many of the newest and largest mills.

TAPERED ROLLER . . . STRAIGHT ROLLER . . . BALL BEARINGS

ITEMS OF INTEREST

D. A. Barrett, vice president of the Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania, will assume supervision, effective immediately, of all industrial relations activities of the company, including personnel, training, labor relations, safety and welfare.

Mr. Barrett has a record of forty-two years continuous service in the United States Steel Corporation subsidiaries, and predecessor companies, and has acted in a supervisory capacity since 1901. He was hot mill foreman at the former La Belle Works in that year and three years later became superintendent

D. A. BARRETT

there. From 1904 until 1928, he served the American Sheet and Tin Plate Company as superintendent or manager in plants in the Ohio Valley and at Vandergrift, Pennsylvania. He became assistant to vice president on January 1, 1929, and was elected vice president on January 1, 1933. He served as vice president in charge of operations for the American Sheet and Tin Plate Company for three years. On June 1, 1936, he became vice president of the Carnegie-Illinois Steel Corporation.

▲

Andrew W. Soderberg, originator of the "rocking shear" principle for cutting wide steel plate, will retire May 31, as chief engineer of the Homestead Works of the Carnegie-Illinois Steel Corporation.

Mr. Soderberg, who will retire on his seventieth birthday, is completing his forty-ninth year of service to Carnegie-Illinois Steel Corporation and its predecessor company. During the period he progressed from his first work of handling simple drawings and blueprints to execution of a total of $100,000,000 in appropriations for modernization and expansion of Homestead Works. His most distinguished work was construction, in 1936, of the 100-inch semi-continuous plate mill.

While making plans for the plate mill, Mr. Soderberg anticipated the difficulty of bow that would result if 90-inch plates were to be cut by straight-edged shears and subsequently devised and patented an 80-ton rocker-shaped shear which has become a mechanical feature of modern plate mill operations.

Among Mr. Soderberg's other accomplishments was included complete electrification of Homestead structural mills.

Mr. Soderberg was born in Sweden, May 31, 1868, and was educated in public schools there and in the United States. He was employed at Homestead by the former Carnegie Steel Company, December 2, 1889, and in 1902 became assistant chief mechanical engineer. He was appointed chief mechanical engineer in 1915, and chief engineer in 1937.

Mr. Soderberg has been an active member of the Association of Iron and Steel Engineers for several years. He is also a member of the American Iron and Steel Institute.

▲

F. H. Kittredge has retired from active service in the United States Steel Corporation, where he was electrical engineer in charge at the Joilet Works of the American Steel and Wire Company.

Mr. Kittredge started with the Illinois Steel Company at South Works in 1891, in the graphical statement department. In 1892, he was at the head of the delay department. At the beginning of 1893, he left South Works for one and a half years, returning

A. W. SODERBERG, chief engineer, Homestead works, Carnegie-Illinois Steel Corp., will retire on May 31, 1938, his seventieth birthday. Mr. Soderberg, as illustrated conceived the idea for the "rocking shear" from watching an old fashioned rocking chair.

in 1894 to the electrical department. In 1898, he was promoted to assistant electrical engineer, and held this office until 1904, when he was transferred to the Joilet Works of the former Illinois Steel Company, as electrical engineer in charge, retaining this position until his retirement. On January 1, 1937, the Joilet

F. H. KITTREDGE

Plant was taken over by the American Steel and Wire Company. Mr. Kittredge served the United States Steel Corporation for over forty-five years.

Mr. Kittredge was educated in the public schools of Minneapolis, Minnesota, he was graduated from the Minneapolis Academy, and took a special course in the State University at Minneapolis. For many years Mr. Kittredge has been actively interested in the Association of Iron and Steel Engineers. He is a charter member of the Association, having been in attendance at the first meeting thirty-one years ago. In the year 1915, he became First Vice-President of the Association.

▲

Bon J. Ballard, Pittsburgh District Manager, Reliance Electric and Engineering Company has moved his offices from the Koppers Building to the Park Building, 355 Fifth Avenue, Pittsburgh, Pennsylvania. Mr. Ballard has been located in Pittsburgh for Reliance Electric and Engineering Co. as district manager for 18 years. He has been an associate member of the Association of Iron and Steel Engineers since 1920.

▲

Rutherford Harris will be located in the New York City sales offices of the Reliance Electric and Engineering Company of Cleveland, Ohio. Other additions to the Reliance staff are: George E. Bevis, who will be located at Syracuse, New York, sales offices; C. R. Newpher, has joined the staff at Cleveland, Ohio. Reliance also announces the moving of their Boston office to 176 Federal Street, Boston, Massachusetts, and the moving of their New York office to 110 East 42nd Street, New York, New York.

J. B. Tytus was elected vice president in charge of operations for the American Rolling Mill Company, Middletown, Ohio. Mr. Tytus began as a clerk in 1904, and worked up through positions of increased responsibilities. Mr. Tytus was awarded the Gary medal by the American Iron and Steel Institute, several years ago, for his part in the development of the continuous rolling process in the manufacture of iron and steel sheets. He was named vice president of Armco in charge of processing developments in 1927.

▲

Frank H. Fanning was named assistant vice president in charge of operations for the American Rolling Mill Company, Middletown, Ohio. Mr. Fanning, who joined the Company in 1909, was associated with Mr. Tytus in 1912 during the early days of East Works Armco mill at Middletown, Ohio. He later served on numerous special assignments, and became assistant to the executive vice president in 1933.

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M. J. van Leeuwen has recently joined the staff in the Chicago sales office of the Square D Company. Mr. van Leeuwen, a graduate of the United States Naval Academy at Annapolis, Maryland, has been

M. J. VAN LEEUWEN

actively engaged in sales engineering since 1923. He has been associated consecutively, with the Condit Electrical Manufacturing Company, the Rowan Controller Company, the Lintern Corporation, the Yale and Towne Manufacturing Company, and until recently the Bull Dog Electric Products Company. Mr. van Leeuwen has been an associate member of the Association of Iron and Steel Engineers for several years.

▲

H. S. Sylvester, formerly works auditor of the Carnegie-Illinois Steel Corporation's plant at South Chicago, Illinois, was appointed general works auditor, in charge of works accounting. His new offices will

(*Please turn to page 76*)

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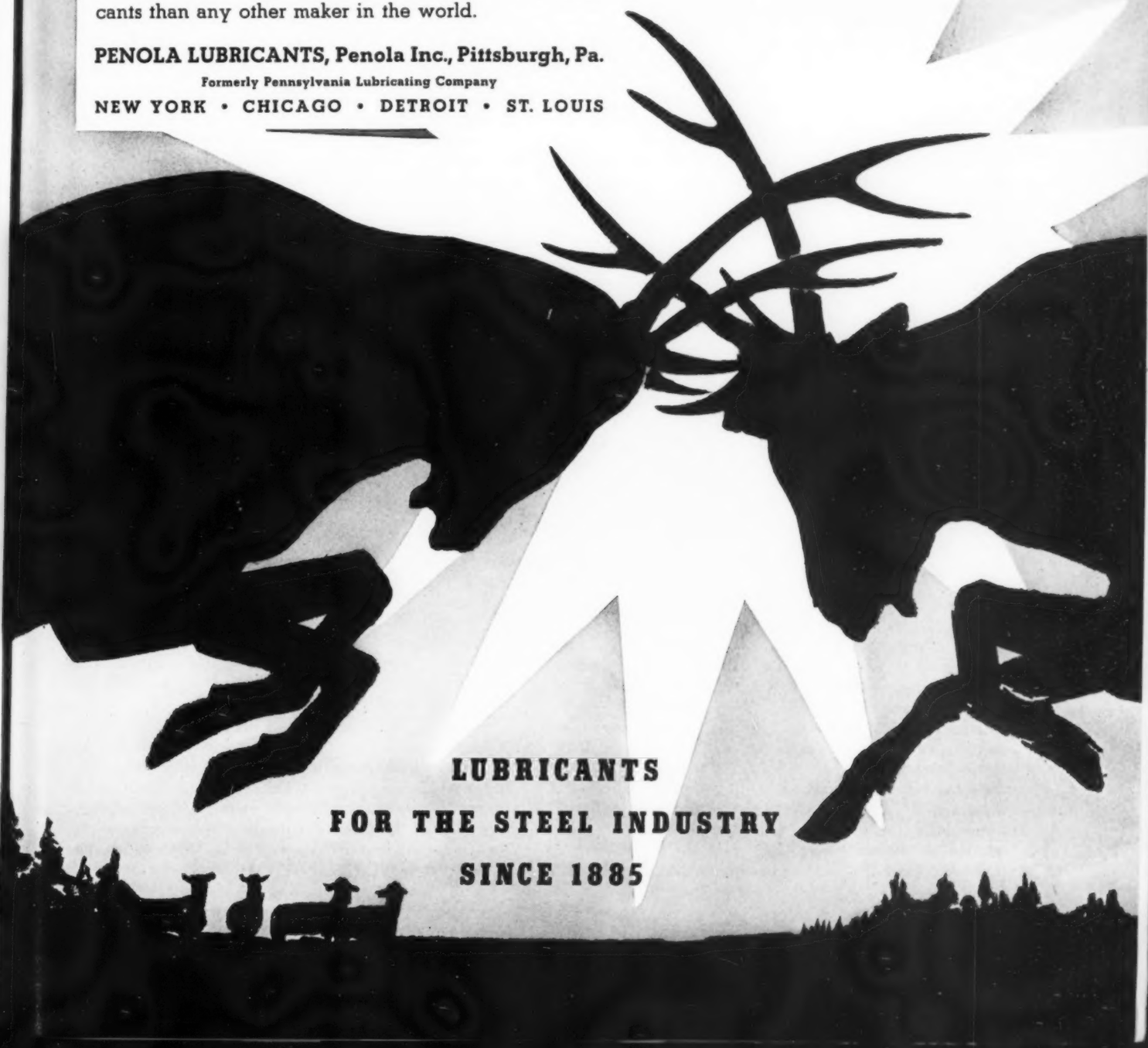

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be in the comptroller's department at Pittsburgh, Pennsylvania. Mr. Sylvester has been connected with the South Chicago plant since 1900, when he began as a plate mill inspector. He was made chief shipper in 1903, and seven years later became chief clerk, accounting department. In 1915, he was appointed assistant works auditor, and in 1928 became works auditor.

▲

J. L. Hull succeeded H. S. Sylvester as works auditor at the South Chicago plant of the Carnegie-Illinois Steel Corporation, Chicago, Illinois. Mr. Hull has been with Carnegie-Illinois Steel Corporation since 1904, when he began as a car record clerk in the yard department of its South Chicago works. He joined the accounting department in 1906 as a stock clerk, later serving as shipping clerk, assistant chief clerk and chief clerk. He became assistant works auditor in 1928, and has held this position until his present appointment.

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D. E. Batesole, formerly assistant chief engineer of the Norma-Hoffmann Bearings Corporation, Stamford, Connecticut, was appointed chief engineer of that company. Mr. Batesole, who succeeds the late George R. Bott, has been a member of the Association for the past fourteen years.

▲

T. E. Rounds, formerly of the engineering department of the Norma-Hoffman Bearings Corporation, Stamford, Connecticut, succeeded D. E. Batesole as assistant chief engineer.

▲

T. Lane Watson was advanced to the position of assistant manager of sales, Chicago district, for the Carnegie-Illinois Steel Corporation. Mr. Watson has a continuous record of service with United States Steel Corporation subsidiaries since he was employed by the former Carnegie Steel Company at Pittsburgh in 1910. He has served in executive positions in the Pittsburgh and Cleveland sales offices and since November, 1936, has served in Chicago in charge of the bar, strip and semi-finished materials division.

▲

William P. Andrews, was appointed manager of sales, Cincinnati district, Carnegie-Illinois Steel Corporation. Mr. Andrews, formerly assistant manager of sales, Chicago district, assumes the position made vacant recently by the death of Lawrence K. Slaback of Cincinnati.

Mr. Andrews has a seventeen year service record with United States Steel Corporation subsidiaries which began in 1921 when he was weighmaster at the Gary Tin Mills of the former American Sheet and Tin Plate Company. He spent two years as a sales student following which he was appointed a sales representative in the New York office. Later he served in the same capacity in Chicago and Minneapolis and in June, 1934 was appointed assistant manager of sales in the Chicago district. He continued in the same position from the formation of Carnegie-Illinois in 1936 until his present appointment.

Frederick D. Foote was elected president of the Alloys Development Corporation of New York, located in Rockefeller Center, New York City.

Mr. Foote has been in the railway equipment business since 1912, when he was located with the Greenville Steel Car Company. He successfully held the positions of purchasing agent, secretary and treasurer, and president. In 1933, Mr. Foote became connected with the United States Steel Corporation, as railroad industrial executive in the commercial offices of United States Steel. He held this position until his present affiliation.

▲

Dr. Beram D. Saklatwalla will be associated with Frederick D. Foote, in the firm of Saklatwalla & Foote. Dr. Saklatwalla has done extensive research work on corrosion and other metallurgical fields. His work in chromium copper corrosion-resisting steels was recognized when he was awarded the Grasselli Medal in 1924, the third time only that this award has been made to anyone. Mr. Saklatwalla will also be located in Rockefeller Center, New York, New York.

▲

Rey F. Frenger became sales manager of the switchgear division of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania, succeeding W. R. Swoish who was transferred to the northwestern district as head switchgear specialist, with headquarters in Chicago. Mr. Frenger supervised the transfer of the small motor activity of Westinghouse from Springfield, Massachusetts to Lima last November after the new plant was purchased to enable the company to expand its small motor operations. Born in St. Louis, Missouri, Mr. Frenger was graduated from the State College of New Mexico in 1915 and immediately entered the Westinghouse Company's employ.

Prior to his assignment in the small motor division, Mr. Frenger had been manager of the company's micarta division, including factory operations at Trafford, Pennsylvania.

▲

Harold D. Fairweath, vice president and treasurer of the Colt's Patent Firearms Manufacturing Company, Hartford, Connecticut, has been appointed first vice president and treasurer of the company, succeeding the late Frederick T. Moore.

Seven other members of the staff were promoted as a result of Mr. Fairweath's advancement. Dwight G. Phelps and Benjamin F. Conner, divisional vice presidents, were elected vice presidents, Mr. Phelps to have charge of the electrical division, and Mr. Conner the plastics division.

Stephen W. Dimich was made vice president of the small arms division, and George R. Porter, vice president of the auto fan division, of which they had been managers. Harry A. Stevens was made works manager, and Charles H. Cole was named his assistant in charge of the machine gun division. George Webb was appointed assistant works manager in charge of engineering.

Robert E. Chew, vice president of the Ladd Equipment Company, Pittsburgh, Pennsylvania, will direct the handling of the products of General Alloys Company for the territory comprising western Pennsylvania, entire state of West Virginia, Garrett and Allegany Counties in Maryland, and in Ohio the counties along the eastern border. James N. Burke will be associated with Mr. Chew in the Pittsburgh office.

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The Cochrane Corporation, Philadelphia, Pennsylvania, announced the appointment of C. J. Gaskell Company, Falls Building, Memphis, Tennessee, as district representative for all of its products in Arkansas, western Tennessee and northern Mississippi.

▲

C. William Howat, Jr. becomes manager of sales for the Thomas Flexible Coupling Company, Warren, Pennsylvania. Mr. Howat, until his resignation, was assistant manager of steel castings sales for Allegheny Steel Company, Brackenridge, Pennsylvania.

▲

Obituaries

Gilbert D. Boyd, aged fifty-two, vice president of the Wallingford Steel Company, died Tuesday evening, March 29, at his home in Wallingford, Connecticut. Born in Worcester, Massachusetts, May 20, 1886, Mr. Boyd attended the grade schools and later prepared for college at Dean Academy, graduating in 1903. Entering Worcester Tech, where he pursued a mechanical engineering course, Mr. Boyd later transferred to Tufts. He was employed by the Rood and Price Screw Products Manufacturers, and later became affiliated with the American Steel and Wire Company on the chief engineer's staff. In 1911 he was appointed assistant superintendent of the cold steel division, and in 1914 resigned and accepted a position as efficiency engineer with the American Tube and Stamping Company, in Bridgeport, Connecticut.

In 1922, Mr. Boyd was active in organizing the Wallingford Steel Company, and had been engaged by them up to the time of his death. Mr. Boyd was an active member of the Association of Iron and Steel Engineers.

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Edgar White Wagenseil, sales manager of Hagan Corporation, and a resident of Oakmont, Pittsburgh, died suddenly, May 10, while engaged in his official duties. He was 54 years old.

Mr. Wagenseil was born at Port Huron, Michigan, in 1884. He was graduated from the University of Illinois in 1905, and was first employed by Illinois Steel Company as steam engineer at their South Works plant.

He was later associated with the Chicago Smoke Abatement Commission and with the Burke Furnace Company, manufacturers of furnaces and stokers.

During the World War, Mr. Wagenseil was an officer in the Aviation Division of the U. S. Navy Department. Following the war he was connected successively with the Harrington Stoker Company, Westinghouse Company, and later with Blaw-Knox, where he was engaged for five years in selling preheaters in the steel industry.

For the past six years Mr. Wagenseil has been general sales manager of Hagan Corporation and its subsidiaries, The Buromin Company and Hall Laboratories, Inc.

He was a member of the Association of Iron and Steel Engineers, American Society of Mechanical Engineers, the Engineers' Society of Western Pennsylvania, and the Pittsburgh Field Club.

GILBERT D. BOYD

EDGAR WHITE WAGENSEIL

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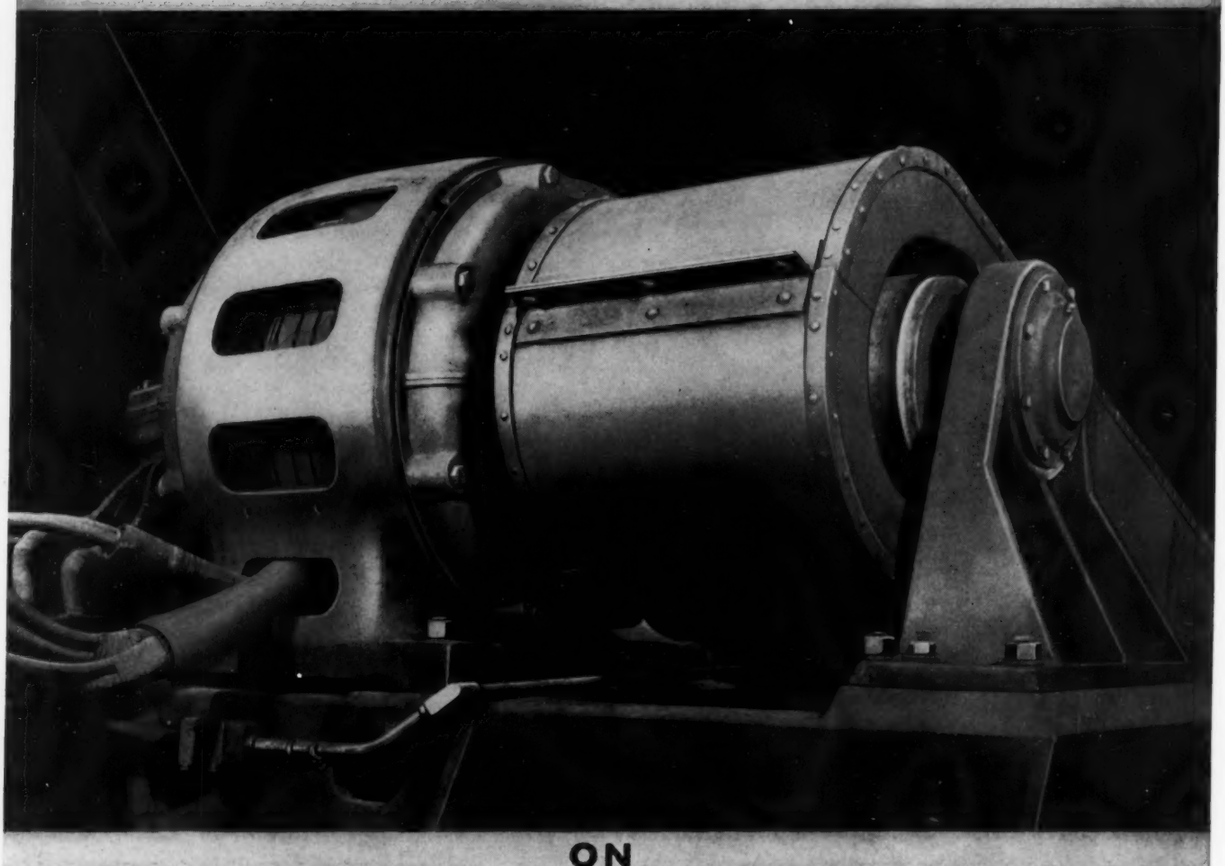

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